THE

ASTRONOMICAL REGISTER:

A MEDIUM OF COMMUNICATION
FOR AMATEUR OBSERVERS, AND ALL OTHERS INTERESTED IN THE
SCIENCE OF ASTRONOMY.

VOL. XX.
NOS. 229 TO 240: JANUARY TO DECEMBER, 1882.

LONDON:
J. D. POTTER, 31, POULTRY, & 11, KING STREET, TOWER HILL.
1883.

LONDON:
ALABASTER, PASSMORE, & SONS, FANN STREET, E.C.
1883.

THE ASTRONOMICAL REGISTER.

INDEX TO VOLUME XX.

ENGRAVINGS.

Notices to Correspondents, &c., &c.

The Astronomical Register.

No. 229. JANUARY. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1881—82.

Second Meeting after the long vacation, December 9th, 1881.

E. Dunkin, Esq., *Vice-President*, in the Chair.

Secretaries—J. W. L. Glaisher, Esq., and W. H. M. Christie, Esq.

The minutes of the preceding meeting were read and confirmed. Mr. Christie announced the receipt of seventy presents since the last meeting of the Society.

John McCance, Esq., of Rathfern, Rayner's Road, Putney Hill, S.W.,

was balloted for, and duly elected, a fellow of the Society.

Mr. Rand Capron, Mr. Downing, and Mr. Lecky were appointed auditors of the Society's accounts for the past year.

Mr. Common read a paper *On silvering large mirrors.* He explained that he had devised a method of holding the mirror while silvering. The chief difficulty in silvering large mirrors was due to their weight and the difficulty of handling them and turning them face downwards into the silvering solution, so as to avoid bubbles. His own mirror was 37-in. in diameter and 4½-in. thick, and weighed over 400 pounds. It was difficult to handle such a heavy mass of glass, and turn it over without doing some damage with the tackling and pulleys that were necessary to move it. The plan which he had adopted was to make use of a large sucker to hold the mirror. The atmospheric

pressure was partly removed, and the sucker could then be attached to pulleys, and carried the mirror along with it. The sucker consisted of a shallow cylindrical iron box, which rested upon an india-rubber ring at the back of the mirror. The atmospheric pressure was removed by means of an air-pump, and a mercury gauge attached to the box showed the amount of exhaustion. In the first instance he had found that he could produce nearly exhaustion enough with his own lungs, by sucking the air from a tube attached to the box. He found that a difference of four inches of mercury between the atmospheric pressure and the pressure within the box was amply sufficient to lift the weight of the mirror. For silvering solution he made use of nitrate of silver and glucose, and got a very good film in about forty minutes, so that if the flat became dewed while he was observing, he had no hesitation in removing the film, and could resilver it and have it back in its place within an hour.

Mr. Dunkin: All I can say is that I hope Mr. Common will some day succeed in making a larger telescope than he has already done.

Mr. Waters asked if Mr. Common found his mirror, after resilvering, answer as well as when he first used it?

Mr. Common: When the mirror was first silvered, in the autumn of 1879, I devoted it principally to the observation of the satellites of Mars. Those are not exactly objects which will give a good idea of what a mirror will do, on account of the glare and disturbance; but I think I have a better film with this process than I had before. I observed Saturn last year, and during 1879, and I got a few observations of Mimas near the end of the ring. With regard to another test, I turned it on Mars, and on the 1st of December I saw Deimos pretty plainly. The night was very light, owing to the bright moon.

Mr. Stone read a paper on a new form of transit circle, with a prismatic object-glass. He said: I propose to make use of a prism instead of the crown glass lens for the object-glass. The light will enter one face of the prism, and after suffering total internal reflection at another face, will pass out of the back or third face of the prism, which must be ground with a concave surface attached to it; there will be a flint-glass convex lens, so as to form with the prism an achromatic object-glass in which the rays enter in one direction, and after reflection at right angles, are brought to a focus. I have calculated the curves necessary to bring three rays of the spectrum, C, D, and F, to a common focus at a distance of 100-in., and find that the curves for such an object-glass would not be inconveniently deep, and that there would be but little spherical aberration. The axis of

the instrument would be placed horizontally east and west. The observer would consequently remain always in one position, and, by merely turning the instrument round its axis, would be able to observe stars at any altitude. It is obvious that there would be many conveniences about such a plan, and that an observer would be able to observe more stars north of the zenith than with the present form of instrument.

Mr. Marth produced a copy of the *Astronomische Nachrichten,* containing a paper by Steinheil. The plate illustrating the paper was missing from the Society's copy; but he believed that Steinheil's plan was very similar to that proposed by Mr. Stone. He understood that Steinheil had had a small instrument, of three or four inches aperture, constructed.

Mr. Christie: I don't know whether I understand Mr. Stone correctly, that he uses a flint lens, and in front of that a crown-glass prism, with the concave surface in contact with the flint?

Mr. Stone: Yes; that is so.

Mr. Christie: Mr. Stone seems to have corrected the spherical aberration; but some time ago I discussed this problem, and found that there were great difficulties in correcting the spherical aberration. I wished to contrive a form of spectroscope in which a flint prism was placed in contact with the lens of the collimator. But though it was easy to correct the chromatic aberration, I found that I could not correct the spherical aberration; at least, I could not with a crown lens behind the prism, keeping the two surfaces in contact and the outer surface of the lens pretty nearly plain.

Mr. Stone: The spherical aberration has been, I think, correctly worked out: and I found that I could get rid of it for parallel rays. There may be a difficulty in correcting the spherical aberration, for an object not at an infinite distance, but for parallel rays it is satisfactorily got rid of.

Mr. Christie: In the form for the spectroscope, I intended to stick a lens on to the last prism, and in that case I could not correct the spherical aberration. I quite agree as to the convenience of the form of Mr. Stone's instrument, and shall be glad if the difficulties can be got over. There was a very nice transit-circle at the South Kensington Loan Collection, on a somewhat similar principle, but the prism was placed in front of the object-glass, and that was liable to objection, because you could not secure a firm connection between the two. There is one other point, and that is the large amount of absorption of light in passing through a thick prism; and if we are going to use a large object-glass, that would be a very serious matter indeed. If we use a 4-in. object-glass, we should lose half the light; and if we

use an 8-in. object-glass, we should lose three-quarters of the light.

Mr. Stone: I have worked the problem out, thinking I might be able to use a prism with a slight curvature on the front face of the prism, but I found the dimensions of the prism came in and caused chromatic dispersion.

Mr. Marth said Mr. Carrington constructed a very large altazimuth with a prism before the object-glass. It was about 6-in. in diameter, and consequently much of the light was lost by absorption. There are great difficulties connected with the use of such large prisms. Mr. Stone gave as his reason for adopting such a form of instrument the difficulty connected with the flexure of the telescope, when the prism is between the object-glass and the eye-end. In the year 1862 I published a method of determining the flexure in any direction of a telescope, which is not only applicable for instruments of the ordinary form, but which is especially applicable in the case under consideration. At the time I had no means of getting such an instrument constructed, and I had to content myself by making my suggestions public. About 12 years ago a transit-circle was being made by Messrs. Cook, of York, for which a flexure-apparatus for the application of my method was constructed, and in which new methods for the determination of other errors were adopted; though, under the circumstances of the case, I could not get my desire realised of having the instrument made with a prism in the centre. The flexure-apparatus was constructed in 1869, and is, with the transit-circle to which it belongs, still at Messrs. Cooke's. In December, 1878, there appeared in the *Comptes Rendus* of the Paris Academy a paper by M. Loewy, of the Paris Observatory, in which he proposed to make use of a flexure-apparatus. He referred to my paper in the *Astronomische Nachrichten*, and raised some objections which were a great puzzle to me. The idea of constructing a flexure-reading apparatus, in the centre of the instrument, has been adopted by him, and quite lately there has appeared a description of his instrument. He adopts the idea of my apparatus, but makes alterations about which astronomers will form their own judgment by-and-by. I have hitherto refrained from saying anything about M. Loewy's objections, as I could not learn how he fastens his apparatus so as to meet some of the very objections which he raises. A description of his instrument has lately been published, which is not yet amongst the presents here. The other day, however, I had an opportunity of glancing over it, and, while wondering how the apparatus for the great meridian circle is fastened, I was surprised to find that the improved apparatus

made for the Bischoffsheim transit-circle is fastened in a manner approaching that in the original apparatus. Mr. Wigglesworth, the new partner of Messrs. Cooke and Sons, has completed the instrument, and he, I believe, intends to bring it up and show it at a meeting of the Society, so that those who take an interest in the subject will be able to examine it and compare it with the form adopted by M. Loewy. I want to suggest to Mr. Stone not to press on with his prism, by which he will lose so much light; for the difficulties he wishes to avoid can be overcome by the application of a flexure-apparatus, which I will then explain.

Mr. Stone: It will be an expensive experiment to try, and it is not worth trying unless there is a fair ground to expect success. I do not think the loss of light will be so enormous as Mr. Marth seems to think. There is no loss at the reflection on the inside of the prism, for it is a total reflection. There is a certain amount of dispersion loss by the absorption of the glass. If I remember rightly, Mr. Carrington's prism was intended to rotate, while the object-glass remained fixed.

Mr. Marth: No; that prism and the instrument, which had cost about £800, was sold at Mr. Carrington's sale for some fifty pounds.

Mr. Stone: I think it is likely that this experiment may be tried with an object-glass made with Mr. Carrington's prism. (Laughter.)

Mr. Christie: I have made a great number of measures of the absorption of light through glass, and I find that the light is reduced to one half in passing through a thickness varying from 3 to 4 inches. Other experiments have been made by a German philosopher, and his experiments agree substantially with mine, that is, that the co-efficient of absorption is such that 50 per cent. of the light is lost in passing through a thickness of glass of three or four inches, and it will be reduced to one-quarter in passing through six or eight inches, and so on in geometrical ratio. Of course, for small glasses that is not so important, but for a large one it is important. I think that generally, in the construction of optical instruments, the absorption of light through different thicknesses of glass has been much overlooked, especially in the case of the spectroscope; and it is liable to be overlooked also in those telescopes where prisms of total reflection are used.

Mr. Common: I remember that, two years ago, Mr. Christie said the same thing about the very great absorption of glass of considerable thickness. About eighteen months ago I tried a $5\frac{1}{2}$-in. prism of glass, of beautiful quality, from Mr. Hilger. I tried, on several nights, the prism against a silver flat, not in the very best condition. I selected a part of the heavens which

I knew nothing about, and tried to count how many stars I could see when the prism was on, and I made a sketch. Then I used the silver plate, and found how many more I could add to them. Then I put the prism in again, and I could not see some of the stars with the prism that I found with the silver flat; and I was strongly impressed with what Mr. Christie had said.

Mr. Ranyard: It is evident that with a prism there is a certain aperture beyond which no advantage will be gained. For example, if a thickness of 3-in. of glass only allows a quarter of the light to pass through, a thickness of 6-in. will only allow a quarter of a quarter of the light to pass through, so that a prism of 6-in. aperture, which has four times the area of a similar prism of 3-in. diameter, will, by reason of the absorption, only be as effective as the 3-in. prism, and beyond that the absorption would beat the increase of aperture.

Mr. Stone read a note on Messrs. Campbell and Neison's paper *On the parallactic inequality in the moon's motion*, published in the September number of the *Monthly Notices*. He said: This paper is in a form which requires some further investigation. Some time back, Messrs. Campbell and Neison brought forward a paper on the parallactic inequality, in which they insisted on the existence of a long inequality—of forty-six years' period in the expression for the moon's tabular longitude. On an investigation I made it did not appear to me that this result could be legitimately inferred. It appeared to be confined chiefly to the earlier observations. To test that as far as I could, I have gone into the question, and this is what I find: instead of its being due to the co-efficient of parallactic inequality, it certainly arises from the determination of the semi-diameters. In the great Greenwich volumes of observations Sir G. Airy has given the expressions for the longitudes of the centres as deduced from both limbs of the moon, when both limbs are observed near the full. By merely taking the differences between the excess of observed longitude over the tabular longitude, and dividing it by two, we get the proper correction for the semi-diameter. I have, therefore, gone through the whole of the observations in this way, and divided them into exactly the same groups as Sir George Airy did for the determination of the parallactic inequality; and the result comes out that the 46-years' period inequality is the correction of the semi-diameters, and not of the longitudes. Some error might creep in by reason of the difference in the moon's irradiation at full and at quadrature, or by reason of irregularities of the moon's surface; and it may be desirable that the instruments used in 1750 should be compared with the more perfect transit-circles now used.

As to the paper of Messrs. Campbell and Neison in the *Supplementary Notices*, my results do not agree with theirs at all; but it is simply a question of arithmetic. I believe my results are right; and if so, Messrs. Campbell and Neison must be wrong. Again, as to the supposed error due to the personal equation of Mr. Ellis, between 1843 and 1851, the results I have obtained—as shown in the paper—are in direct variance with the statement made by Messrs. Campbell and Neison.

Mr. Neison: As regards the diameters, our paper rests upon investigations made by myself seven years ago. Mr. Stone has gone over the observations and cannot get the same figure. I did not like to say I was not wrong, because it is seven years ago since I did the work, and I might possibly have made an error; but since that time I have gone over all the observations again and have got exactly the same results as I did before. I can find no possible room for mistake. My results agree, however, with those of Sir George Airy, in his introduction to the Greenwich observations; and his results are obtained almost in the same way as mine. Therefore it seems that some independent observer should go over the calculations too, and I hope that Professor Newcomb is going to do so. In regard to that part of Mr. Stone's paper in which he speaks of applying some corrections for diameters, there is here something extraordinary which I cannot understand, because the results are diametrically opposed to mine. I took Sir George Airy's figures unaltered, and assumed them to be correct. But here, again, I think Professor Newcomb is coming to our assistance and will give the Society his results on this particular point. Then the Society will have three views before it, and will see on which side the majority lies.

Mr. Stone: When Mr. Neison says his results agree with those of the Astronomer-Royal, I think he is under a misapprehension, because the results given by the Astronomer-Royal are for the vertical diameters.

Mr. Neison: I was referring to the statement of Sir George Airy in the volume for 1856.

Mr. Stone: From 1851 to 1855 different values of the semi-diameter were adopted in the *N. A.*, but the corrections can be computed, so that we need not wait for the elaborate investigations of anyone else. The corrections for the semi-diameter of the early observations are extracted from the Greenwich reductions, and these observations indicate that the 46-year period is a correction for the diameter.

The Chairman: Where doctors disagree we can only hope that another, in the shape of Professor Newcomb, will come and say which of the two is right. I should like to ask Mr. Stone, in

reference to the semi-diameters, whether he has really determined the semi-diameter from Bradley's observations, and compared it with that from the circle and transit observations? Our observations from 1812 have been made with Troughton's mural-circle and Troughton's transit-circle, instruments of no great power, but really good instruments, and much more powerful than Bradley's transit and quadrant.

Mr. Stone: I have really referred in this case to the observations themselves. As far as I can see there is only one explanation of the point of difference, and that is, that there is a difference of the effective diameters at quadrature and full moon.

Mr. Christie read a paper *On observations of Venus in the spring of* 1881, by Mr. W. F. Denning. In March and April Venus became a splendid object in the sky; faint markings upon its surface were observed. On March 28 a small bright spot was seen within the north cusp, and on March 31 a bright spot on the north horn was seen. On another occasion a dark shadow was seen on the planet, having the appearance of a crater, but this must have been illusory, as it was difficult to conceive that such an object could be seen unless Venus had no atmosphere.

Mr. Penrose read, and explained by drawings which he exhibited, a paper on a method of finding the elements of the orbit of a comet by a graphic process, which he showed to be capable of considerable exactness.

The paper and the necessary diagrams will be printed in the *Monthly Notices.*

Mr. Common read a paper *On observations of Mimas.* The weather during November was very fine, and he had succeeded in observing several conjunctions of the satellites with the ends of the ring, in the manner recommended by Mr. Marth. He had caught it before it came to conjunction coming upwards, and followed it across to its conjunction, coming inward, but more than that he had not been able to do. He had also seen Hyperion easily at all times, but Mimas only under certain circumstances, and better at conjunction than any other time. He had also seen Deimos, the outer satellite of Mars, on the 1st of December, but could not take measures. It was in the place where it ought to be according to the ephemeris.

The Chairman announced that a letter had been received by the Council from Dr. A. H. Murray, the editor of the dictionary of the Philological Society, asking for information with respect to the introduction of the word *perihelion.* Dr. Murray says, "Can you help me to ascertain, for the new English dictionary of the Philological Society, who first introduced the terms *aphelion* and *perihelion?* I find Hobbes used *perihelion* (in Latin) in 1642.

Perhaps a reference to some astronomical works would settle the question. I should be glad to know if they were used by Copernicus, Kepler, or any of the earlier astronomers. I should be greatly obliged if you would ask the question at one of your meetings; we want to make the dictionary as complete as possible in the biography of every word."

Mr. Christie said that Mr. Wesley had taken some trouble to look up the early use of the words, and had found in a work by Kepler, *Prodromus dissertationum cosmographicarum* (Tubingae, 1596) the following passage: "Et quia ad declinandos hos errores necesse fuit, fundamentum veluti mundi in ipsum Solis centrum reponere, hinc adeo factum. ut loca zodiaci, quibus planetae fiunt altissimi et humilissimi, non jam amplius *apogaeorum* et *perigaeorum* nomen retinere possent, ut quidem in Copernico retinuerunt abusive, sed proprie et significanter indigarentur, a me *aphelia* et *perihelia*." From this it would appear that the two latter words were introduced by Kepler. He also finds in Kepler's *Epitomes Astronomiae Copernicanae* (Francofurti, 1621), Liber VI., pars 1: "Si de vero telluris motu agimus, dicuntur aphelium et perihelium, ut in planetio ceteris primariis, et tunc aphelium Telluris hodie est in 6° in Capricornus; sin autem ut de Solis apparenti motu loquimur, manent iis eadem nomina, quae in astronomia veteri, dicunturque apogaeum et perigaeum, et tunc apogaeum Solio est in 6° in Cancer." With regard to the words *apogee* and *perigee*, which Kepler here states to have been employed *in the old astronomy*, Mr. Wesley says: "They are, I presume, much more ancient than *aphelion* and *perihelion*. Grant says (Hist. Phys. Astron., p. 437) that Hipparchus 'deduced the eccentricity of the solar orbit, and also the place of the apogee.' It occurred to me, therefore, that possibly the *words* apogee and perigee might have been used by Hipparchus. I, therefore, have searched for them in Aratus (De Phaenomena) in which work I believe the fragments of Hipparchus are preserved, but have not been able to find them."

The following papers were also announced and partly read:

W. F. Denning: *On radiant points of shooting stars observed at Bristol in the years* 1878 *and* 1879.

W. E. Plummer: *On the motion of the companion of Sirius.*

Prof. C. Pritchard: *Note on the variable star D. M.* + 1° *No.* 3408.

A. Marth: *On the conjunctions of the satellites of Uranus with each other, which may be observable from February to June* 1882.

W. F. Denning: *Note on the discovery of comet* 1881, *c* (*Schäberle*).

The meeting adjourned at ten o'clock.

THE LUNAR RILLS (CLEFTS).

(Continued from page 309, Vol. XIX.)

No.

27. + 1° + 7°. 83 miles. 9h. A narrow, cleft-like valley, very straight, lying in a direction which is the prevalent one in this region. The breadth of the valley increases to 12,800 feet at its southern extremity, that of its northern portion being only 4,500 to 5,100 feet, and in many places there are elongated (crateriform?) enlargements. The tops of the banks of the wider portion of the cleft are tolerably conspicuous on the north-west side, but those on the opposite side are very difficult of detection. The cleft may be said to open into the *Sinus Medii* at the point just mentioned. Close by are three very narrow valleys, much shorter than No. 27, which open in exactly the same direction.

28. + 4° + 4°. 92 miles. Direction varying. Minute and difficult to see. At the middle of its course, not far from the foot of *Triesnecker*, it forms a "knee-like" angle, and is here most distinct. The northern portion is least complex, and is slightly curved, the chord of the curve having the direction 2h. The southern part is exactly equal in length to the northern, and, while slightly undulating, follows the general direction 11h. In both portions the cleft inosculates with many others.

29. + 4° + 3°. 39 miles. 11h. A cleft which enters 28, and curves considerably before the junction takes place. Its southern and longer segment is about 2,600 feet wide, and was first seen by us on February 26th, 1833. The yet more delicate northern portion, near the mouth, is scarcely 1,900 feet wide, and first displayed itself on April 26th. The whole lies in an open plain.

30. + 3° + 2°. 20 miles. 8h. Straight, in a plain, and ends both ways in a small bright mountain.

31. + 3° + 1°. 24 miles. In meridian. Lies at the foot of a minute ridge. Straight, and very difficult.

32. + 4° + 6°. 32 miles. 1h. to 2h. Lies, like No. 31, at the foot of a ridge of hills. Slightly curved. Its southern is *o* on the wall of *Triesnecker*.

33. + 5° + 7°. 24 miles. oh. to 1h. Curved, like the preceding, and at first accompanied by a ridge. Its northern end is a crater. Possibly 32 and 33 are connected, and thus intersect the next (34).

34. + 4° + 7°. 88 miles. 10½h. Repeatedly but only

slightly curved. It begins at the foot of a small mountain, and intersects 28 γ, after a course of 19 miles. 17 miles further on it meets a small ridge of hills (that already mentioned in connection with 32 and 33) interrupts it. The middle portion is the most distinct, and was also that first seen by us, the remainder not having been detected until two months later. The end is in a bright plain about $5\frac{1}{2}$ miles from the foot of a lofty mountain. The clefts entered under the numbers 28 to 34 do not appear in Lohrmann's Section I.; but, on the other hand, there are many (of them) in his subsequently-issued General Map, where also some are shown which we have not detected. The extreme delicacy of the majority of the clefts in this district will readily account for this. . . . Measurements of such objects are also impracticable, and a difference between the representations given by two perfectly independent observers is exceedingly natural.

35. — 8° + 61°. 11 miles. 10h. Between (chains of) high mountains, lying almost perpendicular to the direction of the cleft, which is straight and about 3,800 feet in breadth.

36. — 10° + 62°. 8 miles. Direction not given. Straight, connecting the crater *Fontenelle b* with the mountain μ; surrounded by steep and lofty hills. In this region there are many cleft-like valleys formed (bounded by) perfectly straight mountain walls.

37. — 20° + 53°. 27 miles. 2h. Straight, and accompanied by many rows of hills lying in the same direction. Its southern end abuts upon the crater *Plato c.*

38. — 50° + 25°. 116 miles. (Direction varying considerably at different points of its course.) Discovered by Schroeter. The remarkable cleft near *Herodotus*. It begins close to the mountain *Herodotus E*, in a hilly region, and is probably connected with a small ravine which intersects the hilly country at this spot. In the first fourth of its course (the cleft) is very slender and shallow. At *Herodotus M* it makes two sudden bends, completely changes its direction, becomes wider, more rugged, and deeper, (so that) the shadow cast internally from the walls can be detected. At the mountain *Aristarchus* ζ, which rises pretty steeply to a height of 3,587 feet above the plain on the further (eastern) side, (the cleft) turns once more, and now pursues, with but little winding, a course almost directly opposed to that

formerly followed, with a width of 11,500 to 12,800 feet. Eleven miles from the mouth a minute and difficult crater lies at the bottom of the cleft. The western bank at this point rises some 4,500 feet above the surface at the opposite side (of the cleft). The cleft narrows again considerably shortly before opening into the basin of *Herodotus,* and it is difficult to follow it quite up to β. The considerable and abrupt changes of direction make the determination of the optical, and still more of the real length, very unreliable. At full it can easily be perceived as a bright line under most angles of illumination, but a coincidence of favourable circumstances is requisite to enable all the details enumerated to be made out.

39. — $1^\circ + 23^\circ$. 39 miles. 3h. Slightly curved. This cleft intersects many not inconsiderable mountains, and ends at a conspicuous hill. Seen with difficulty.

40. — $2^\circ + 26^\circ$. 89 miles. At right angles to No. 39. 11 miles from the junction (of 39 and 40) an enlargement becomes apparent, as well as a greater elevation of the banks. Further on there are many slight curvatures (in the cleft), and some hills approach close to it. It ends at hills forming a part of the outworks of *Archimedes.*

41. — $22^\circ + 13^\circ$. 30 miles. 4h. Straight, lying among densely-crowded hills of moderate height. Two steep walls terminate it—that of *Gay Tussac* on the W., and that of the high mountain ζ on the E.

WILLIAM RADCLIFF BIRT.

It is with deep regret that we have to announce to our readers the death of one of our oldest and most constant contributors. The name of Mr. W. R. Birt is well known to the readers of the *Astronomical Register* as that of a veteran selenographer. It is now nearly half a century ago that he commenced his scientific career by entering upon the study of meteorology; and a little later he devoted himself to the reduction and discussion of a large collection of notes of meteorological observations collected by Sir John Herschel from all parts of the world. In the course of this work he discovered the existence of a great atmospheric wave, recurring annually in the month of November, and which it has since been suggested may have some connection with the November meteor showers. This discovery led Mr. Birt onward

in meteorological studies, the result of which he afterwards embodied in his *Handbook of the Law of Storms.* In 1848, he was employed to reduce a mass of observations of Atmospheric Electricity, of which he published a report in the following year. In 1859 he was elected a Fellow of the Royal Astronomical Society, and from that time he devoted himself almost exclusively to the study of the surface of the moon; and for several years acted as Secretary to the Lunar Committee appointed by the British Association. It was at this time that he devised a method of cataloguing the various objects on the lunar disc, by which he hoped to secure their ready identification in future. The scheme was open to several objections, not the least of which was the enormous labour that its execution would involve; and four maps only, each embracing an area of 25 square degrees, were published. In 1868 he sent his first communication to the *Astronomical Register*, and from the beginning of that year to the present time, hardly a number appeared without some contribution from his pen. Four years ago, on the starting of the Selenographical Society, he was elected its first President, and he was re-elected each year subsequently.

Of late years his increasing age and weakness prevented Mr. Birt's continuing to observe; but to the last he took great delight in the discussion of the notes of observations made by others. His own last observation is numbered 909, and dated June 16th, 1877.

Although his weakness since this date had been steadily increasing, little apprehension of any rapid change seems to have been entertained by those about him, and his death, which occurred on the morning of the 14th ult., was, at the last, almost sudden.

In addition to the *Law of Storms* above mentioned, Mr. Birt was the author of many papers and pamphlets, upwards of forty of which are mentioned in the Royal Society's Catalogue of Scientific Papers.

REVIEW.

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M A., F.R.A.S., Vicar of Hardwick, Herefordshire. Fourth edition, revised and greatly enlarged. London: Longmans, Green & Co. 1881. Pp. xiv.493. Price 9s.

In the advertisement to this edition the author observes that "The unprecedented diffusion of a taste for astronomical observations during the last seven years has brought with it such a corresponding increase in the optical capacity of telescopes in private hands, that the very title of this treatise would convey an inaccurate impression unless its contents

were modified in accordance with the requirements of the time. Without abandoning that elementary character which may still make it serviceable to beginners, its compass must now be greatly extended if it may hope for acceptance as a manual by the more advanced student; and with this object, as the increase of telescopic range chiefly affects the sidereal portion, recourse has been had for additional double stars to the great catalogue of Struve I., as well as in a lesser degree to those of his son and Burnham, and as regards nebulæ to that of Herschel II., with a total increase of about 1,500 objects, some of which are chosen as tests worthy of the finest instruments, but occasionally, as is well known, within reach of those of more moderate dimensions."

The author has also availed himself of much unpublished matter placed at his disposal, and he acknowledges the assistance of many friends, some of whom are mentioned.

The present edition has 150 pages more than the last, a new map of Mars, and a catalogue of meteoric showers. Mr. Webb alludes to the great amount of care and attention involved in its preparation. We doubt not that the continued appreciation of a wide and widening circle will repay the pains he has taken to bring this excellent work up to the requirements of the present day.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

BETA CYGNI.

Sir,—A suspicion has latterly occurred to me that this well-known star may be variable. It used, I think, to be a much more conspicuous object in my early days. It appears to have been shown that Bayer was occasionally guided in affixing his letters by other considerations than mere brightness, so that little help can be expected from him in this case, where he seems to have been influenced by symmetry of configuration. At any rate the matter may be worth this passing notice.

Hardwick Vicarage: November 25, T. W. WEBB.

THE RED SPOT ON JUPITER.

There appears at last to be some change in the appearance of this spot. This evening, at 9·45, I observed a dark mark on the preceding end, so dark that at first it was taken for the shadow of a satellite, and when the spot was fully on the disc of Jupiter. The following end was similarly marked, but not so dark as the

preceding. The border of the spot towards the southern belt was rather darker in colour than the one nearest the pole, and a faint cloudy appearance was visible in the spot, towards its eastern end.

Having made several drawings of this spot lately, I feel assured that these dark ends are recent changes, at all events in their intensity.

39, Circus Road, NATHL. E. GREEN.
St. John's Wood: Dec. 19, 1881.

METEORS AND DENNING'S COMET.

Sir,—According to *Nature* the orbit of Denning's comet passes that of the earth at a distance of only ·0346 in long. 82° 35′. A meteor shower connected with it might therefore reasonably have been expected on the 13th or 14th inst., but it would not be likely to be visible in this country, the radiant point being a southern one. It has been suggested that this comet may be the same as Blanpain's, 1819, IV., the radiant point for which is given in the B. A. Meteor Report for 1875, as calculated by two authorities, at R.A. 347°·5, D. —36°, on Dec. 10, and R.A. 346°·2, D. 44°·5, on Dec. 9, respectively.

Sunderland, Yours truly,
Dec. 12, 1881. T. W. BACKHOUSE.

ERATOSTHENES.

Sir,—Mr. Slack's notice of this formation in the November number of the *Register* induced me to examine it during the present lunation, with the following results: On 30th Nov., between 9h. and 10h., with a power of 250 on an 8½-in. Calver reflector, Mädler's "large central mountain" was represented by three distinct mountains, forming a triangle with the apex N., and a small and much fainter hill a little to the S. On Dec. 2nd, at 7h. 45m., three bright peaks were remarked at each angle of the triangle, and a ridge connecting the two peaks on the E. side with the faint spot on the S. Another small mountain was noticed on the E. side of the floor, about half-way between the centre and the inner terrace of the E. wall, this, with the three bright peaks and ridge, were arranged in the shape of the letter Z, the length of the slanting stroke of the Z being estimated to be about one-fourth of the diameter of the floor of Eratosthenes. On comparing the drawings of this formation, I find that Schröter (after making due allowance for his somewhat conventional mode

of depicting lunar objects) gives a tolerably accurate idea of these central mountains, which he represents as a large V-shaped mass, with a very irregular outline, occupying a considerable proportion of the area of the floor. Beer and Mädler show four objects and Neison three (described as "three central peaks placed in a triangle"), but neither represent all the objects at present visible in the interior.

Bedford: Dec. 7, 1881. J. G. ELGER.

THE LATE LUNAR ECLIPSE.

Sir,—Weather very mild, and sky as propitious as could be desired here for this observation on Dec. 5. A little cloud in N.E. and S.W. horizon prevented the illusion caused by refraction being witnessed, whereby sun and moon might perhaps have been seen above the horizon simultaneously. At 4·32 a portion of the eclipsed disc began to be discernible. Twilight fading, the lunar surface rapidly became more transparent. At 4·55 the western seas (as they are termed) began to stand out dark and prominent through the earth's umbra. At 5·8 a thin silvery streak of moonlight below Petavius, extending about 50° along the lunar edge. A greenish crescent in the eclipsed portion from Mare Fœcunditatis across to Mare Humorum. Redness on disc, greater without than with instrumental aid. Soon after the greatest obscuration, Aristarchus stood out most conspicuously as a white spot in the coppery disc, and continued so till it emerged out of the shadow at 6·1¾. Half the moon illuminated then; the upper part of a light coppery tint to naked eye, partly slate-coloured in telescope. Tycho uncovered 5h. 39¾m.; Grimaldus, 5·44½; Copernicus, 6·6¾. At 6h. 28·21m. ι Tauri disappeared at moon's bright edge, behind Grimaldus, appearing rather minute and nearly overpowered by moon's rays just before immersion. Stars had now dimmed. At 6h. 32·5m. Theophilus uncovered. At 6h. 32·4m. Plato uncovered. Ruddy colour almost vanished. At 6h. 45·15m. Proclus uncovered. The shadow then retreated over the Mare Crisium, but owing to penumbral darkness the lunar circle did not appear complete to naked eye till 6h. 59m.

Melplash, Bridport, Faithfully yours,
Dorset: Dec. 7. S. J. JOHNSON.

METEOR.

Sir,—I observed rather a peculiar meteor here on Tuesday, 15th inst., at about 10h. 3m., p.m., local time. It rose perpen-

dicularly upwards from a point somewhere 3° or 5° to the left-hand side of Canopus (say, R.A. 6h. 20m., S. Dec. 49°). until it reached a point near α and δ Horologii, or R.A. 4h. 10m., Dec. S., 42°. The curious part of it was its phosphorescent track, which remained visible for, I should say, fully three minutes. I counted 150 while it was visible, beginning a little after the meteor was first seen, and I think three minutes a fair estimate of its duration. It reminded me of a long thin comet. I may have been mistaken, but the streak appeared to move to the left, or northwards, while I was looking at it, and I was also under the impression that it became bent, the convexity being towards the right, or southwards.

The duration of visibility of the streak appears in this case unusually long. The only approach to it that I can note is a meteor noted by Mr. Denning, on p. 72 of the *Monthly Notices* R. A. S. for December, 1880, whose duration was 15 seconds.

Pietermaritzburg, Natal: Yours obediently,
Nov. 21, 1881. E. E. M.

COMETS OF 1748.

Sir,—The fact of two bright comets visible to the naked eye, as in the early part of August last, will doubtless attract some attention, and Mr. Johnson's letter (*Register*, Dec., p. 310) will be read with interest in this connection. I believe, however, there must be instances since the year 1618 when the same fact has been recorded. In Chambers's *Astronomy* several comets are mentioned as visible in the spring of 1748, namely:—

I. Discovered at Pekin on April 26th, and by J. D. Maraldi April 30th. Visible to the naked eye, with a tail 2° long.

II. Discovered by Klinkenberg on May 19th, but remained in sight only four days.

III. On April 24th a Dutch navigator, at the Cape of Good Hope, saw a comet, at the beginning of Aries, rise in the E. $\frac{1}{4}$ N.E., at 4 a.m. This is probably the comet rendered invisible at the Cape by a northerly motion, which Kindermannus saw on April 28th, at 2 a.m., at an elevation of 8° above the horizon, in a straight line with (it would seem) δ and η Trianguli and the brightest star of Aries, in longitude 80°, latitude + 28°, and declination +50°. On May 3rd, between 11h. and 12h., the comet was near Perseus and circumpolar (Struyck, *Vervolg*, p. 100).

Ashleydown, Bristol: Yours faithfully,
Dec. 7th, 1881. W. F. DENNING.

LUNAR WORK FOR JANUARY, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

In a letter to the *English Mechanic*, the Rev. J. Bone, of Lancaster, calls attention to "a curious cleft crater, west of Parrot," which is probably Argelander *d*. Neison describes this object as being smaller, but of similar formation to Argelander, and united by deep broad passes to two much smaller objects of the same nature, one at each end. This description does not quite correspond with the object as shown in his map. Drawings, therefore, of Argelander *d* are desirable in order to determine the accuracy of the map or the text.

A question has also been asked in the same periodical as to the existence of a cone-like object in the interior of a crater on the south-eastern wall of Mersenius. Schmidt's great map shows the crater without any central cone, but with a small craterlet on its east wall. The telescope used for the observation on which the query was based was a small one, and the wall of the craterlet, which projects slightly inwards upon the crater, may have been mistaken for a cone. The date of the observation was Dec. 2, 11h. 10m., and the object will be under similar conditions of illumination on Jan. 30, 12h. 38m., when another observation may test the truth of the above supposition.

On Jan. 7 the sun will set on the Mare Crisium, and careful sketches of the region round Proclus are desirable, particular care being taken to show the position of the streaks radiating from it, as seen at this time.

Sirius contains an article on Hyginus *N*, by Professor Schmidt, of Athens. His opinion, based on a series of his own observations, confirms that of Neison and others as to the reality of a change having taken place at this part of the moon's surface during the last three or four years. The region will be well placed for observation on the evening of Jan. 10. Particular attention should be paid to the part immediately north of N, and to the exact shape of the shadows. A white edge, apparently a low wall, has been sometimes suspected on the east border of N. This also should be looked for.

In consequence of the lamented death of Mr. W. R. Birt, who has furnished the notes on Lunar objects for many years, it is requested that drawings and letters on those subjects may be sent for the present to the Rev. Dr. Richards, St. Mary's, Bayswater, W., who is in possession of Mr. Birt's note-books and MSS.

For the benefit of those who desire to study *Cleomedes* a catalogue of the objects within it is appended to the these notes. The nomenclature is in accordance with the method approved by the Selenographical Society, and anyone desiring a tracing of the key-map, will be furnished with one on application by letter to the above address.

Dec. 17, 1881.

Catalogue of Objects within Cleomedes.

Name.	*Objects.*
A	A crater on the N. floor.
A 1	A light streak S.W. from *A*.
A 2	A crater or depression E of *A*.
A 3	Central mountain in *A* 2.
A 4	A depression S. of *A* 2.
B	A crater on the S. floor.

Name.	*Objects.*
C	A crater at the S.E. angle of Cleomedes.
C 1	A peak just N. of *C.*
C 2	A gap in the S.E. wall, N.E. of *C.*
C 3	The W. ridge of *C* 6.
C 4	A craterlet N.E. of C.
C 5	The E. ridge of *C* 6.
C 6	A valley E of *C.*
C 7	A mountain on the S. floor.
C 8	A depression W. of *C* 7.
i	A crater on the S.W. floor.
i 1	A mountain just N.W. of *i* 2.
i 2	A pass at the S.W. angle.
1	A ridge southward from Tralles.
2	The dark surface on the S.E.
3	A ridge S. from Tralles, east of 1.
4	Dark surface on N.W. floor.
5	A mountain on the N. wall.
6	Dark surface on S.W. floor.
7	A ridge on the E. part of the floor.
9	A peak near the S. end of 7.
11	A peak S. of 9.
13	A mountain W. of 9.
15	A mountain just S.W. of *i* 1.
17	A mountain S.W. of 15.
19	The highest peak on the S.W. wall.
21	The interior ridge on the W. border.
23	A peak on 21, near the N. end.
25	A peak on 21 W. of *A*.
27	The S.E. peak on the S.W. wall.
29	The N.W. peak on the S.W. wall.

DUN ECHT CIRCULAR, No. 41.

In a checked telegram of twelve words by the "Science Observer Code" the following particulars have been received from Boston, U.S.

"Mr. Sawyer has discovered that the star D.M. + 1°, 3408 is a variable of the Algol type, with a period of 5·24 days, its brightness varying from 6m·0 to 6m·7; 1881 November 30·84 Greenwich M. T. being an epoch of minimum."

The star's place for 1882·0 is—

A. R. = 17h. 10m. 33s.; Decl. = + 1° 20′·6.

Schjellerup in his Catalogue—Copenhagen 1864—already pointed out, that "This star seems to be variable, as Lalande has 6m but Bessel 7m*; Bremiker in the Academische Sternverzeichniss adds expressly, that he estimates it of the 8th mag.; Argelander has 5m·5. It occurs in Lamont's Zone 101 with 7m. and in Zone 102 with 8m."

Schjellerup has 7m·7 in a clear sky sky on 1863 June 9.

*1822 July 4.

Lord Crawford's Observatory,
Dun Echt: 1881, December 2.

DUN ECHT CIRCULAR, No. 42.

Mons. A. PALISA transmits from Vienna by a "Science Observer Code" telegram new elements and an ephemeris of Comet 1881 g, based on observations taken on November 22, 25 & 27:—

Elements.

$$\begin{aligned} T &= 1881, \text{ December } 8{\cdot}81, \text{ Greenwich M.T.} \\ \pi\text{-}\Omega &= 130^\circ\ 46' \\ \Omega &= 184\ \ 54 \\ i &= 143\ \ 33 \\ \log. q &= 0{\cdot}28267 \end{aligned} \quad \left.\begin{matrix}\\ \\ \\ \end{matrix}\right\} \text{Mean Equinox } 1881{\cdot}0.$$

Ephemeris for Berlin Midnight.

1881		α			δ		Brightness.
Dec. 7	23h	47m	40s	+	46°	10′	1·00
11	23	42	0		41	1	
15	23	38	24		36	22	
19	23	36	24		32	15	0·73

CRAWFORD and BALCARRES.

Dun Echt Observatory, 1881, December 5.

DUN ECHT CIRCULAR, No. 43.

Writing from Währing on Dec. 14, 1881, Mons. J. Palisa sends the following particulars of comet g, 1881 (Swift).

Elements.

$$\begin{aligned} T &= 1881, \text{ Nov. } 20{\cdot}0359 \text{ Berlin M.T.} \\ \pi\text{-}\Omega &= 299^\circ\ 25'\ 25'' \\ \Omega &= 181\ \ 21\ \ 41 \\ i &= 144\ \ 48\ \ \ 6 \\ \log q &= 0{\cdot}284788 \end{aligned} \quad \left.\begin{matrix}\\ \\ \\ \end{matrix}\right\} \text{Mean Equinox } 1881{\cdot}0$$

Computed from observations on Nov. 22, 27, and Dec. 12: Deviations of the middle place:—

$$\Delta \lambda \cos \beta = -9''. \qquad \Delta \beta = +6''.$$

Ephemeris for Berlin Midnight.

1881.	α h.	m.	s.	δ °	′	Brightness.
Dec. 15	23	39	0	+37	1·0	0·65
17	23	37	49	34	58·8	
19	23	36	55	33	4·4	
21	23	36	16	31	17·1	
23	23	35	50	29	36·6	
25	23	35	35	28	2·4	
27	23	35	30	26	35·2	
29	23	35	35	25	14·3	0·42

The brightness on Nov. 22 = 1·00.

Equations for the Equator.

$$\begin{aligned} x &= 9{\cdot}99996 \sin (\ 26^\circ\ 57'{\cdot}0 + v) \\ y &= 9{\cdot}71639 \sin (115\ \ 39{\cdot}7 + v) \\ z &= 9{\cdot}93146 \sin (117\ \ 25{\cdot}6 + v). \end{aligned}$$

Prof. Pickering communicating the discovery of two very interesting objects, writes:—

"On the evening of Nov. 24, I noticed that the spectrum of DM. + 36° 3987 has a bright band in the blue, so that the star seems to belong to the small class of objects like Rayet's stars in the same neighbourhood.

"The next evening I found a very small planetary nebula (place for 1880, 20h. 6m. 26·38s., +37° 3′ 25·2″) south 3′ 10″ of B.-W. XX, 200—1 and following it 8·38s. Except by its spectrum the nebula is undistinguishable from a star of the fourteenth magnitude. Two other faint stars follow it, 2·6s. and 2·3s. respectively, north 37″ and south 20″ of the nebula."

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1881, December 20.

THE PLANETS FOR JANUARY.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	18 41 53	S. 24 45	4″·6	23 53·8
	9th	19 31 46	S. 23 48½	4″·8	0 16·0
	17th	20 28 56	S. 21 11	5″·0	0 41·6
	25th	21 24 15	S. 16 55	5″·4	1 5·3
Venus ...	1st	18 0 32	S. 23 24½	10″·0	23 12·6
	9th	18 44 25	S. 23 20½	10″·0	23 24·9
	17th	19 28 1	S. 22 30	9″·8	23 36·9
	25th	20 10 49	S. 20 56	9″·8	23 48·1
Mars ...	1st	6 15 23	N. 27 4	18″·0	11 29·4
	9th	6 3 7	N. 27 10	17″·4	10 45·7
	17th	5 53 47	N. 27 8	16″·4	10 4·9
	25th	5 48 10	N. 27 1½	15″·2	9 27·9
Jupiter ...	1st	2 46 42	N. 15 44½	42″·0	8 11·2
	9th	2 56 9	N. 15 44½	41″·0	7 39·2
	17th	2 56 29	N. 15 48	40″·0	7 8·1
	25th	2 57 40	N. 15 56	39″·0	6 37·8
Saturn ...	1st	2 16 27	N. 11 2	17″·0	7 31·1
	9th	2 16 20	N. 11 4½	16″·8	6 59·5
	17th	2 16 41	N. 11 9	16″·6	6 28·4
	25th	2 17 28	N. 11 15½	16″·4	5 57·6
Uranus ...	25th	11 17 36	N. 5 26	4″·0	14 56·2
Neptune ...	1st	2 48 1	N. 14 18	...	8 2·6
	17th	2 47 30	N. 14 16½	...	6 59·1

Mercury is badly situated for observation at the beginning of the month, setting nearly with the sun, the interval increasing to an hour and a half after sunset on the last day.

Venus rises nearly an hour before the sun on the 1st, the interval decreasing.

Mars sets at sunrise, at the beginning of the month, and afterwards earlier each night.

Jupiter sets about three hours and a half after midnight on the 1st, the interval increasing.

Saturn sets two hours and a half after midnight at the beginning of the month, the interval increasing.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Jupiter.
Sun	1	15 26 16 24 17 45 18 5	Occultation of ι Tauri (5) Reappearance of ditto Occultation of 105 Tauri (6) Reappearance of ditto Sidereal Time at Mean Noon 18h. 44m. 8·50s.	1st Sh. E. 2nd Sh. E.	4 23 4 31	8 11·2
Mon	2		Near approach of ζ Tauri (3½) Sun's Meridian Passage 4m. 21·53s. after Mean Noon			8 7·2
Tues	3	1 22 58 3 37 4 15 3 58 4 47	Conjunction of Moon and Mars 5° 49′ N. ○ Full Moon Occultation of 16 Geminorum (6) Reappearance of ditto Occultation of 16 Geminorum (4) Reappearance of ditto			8 3·1
Wed	4	5 15 6 6	Occultation of B.A.C. 2432 (6½) Reappearance of ditto Saturn's Ring: Major axis=42″·63 Minor axis=13″·23			7 59·1
Thur	5	15 15 16 2 18 44 19 24	Occultation of 60 Cancri (6) Reappearance of ditto Occultation of B.A.C. 2872 (6) Reappearance of ditto	2nd Tr. I. 1st Tr. I. 1st Sh. I. 2nd Sh. I.	12 58 14 0 15 9 15 14	7 55·1
Fri	6	6	Superior conjunction of Mercury and Sun	1st Oc. D. 1st Ec. R.	11 14 14 33 41	7 51·1
Sat	7	19 50	Near approach of 14 Sextantis (6)	3rd Tr. I. 2nd Oc. D. 3rd Tr. E. 1st Tr. I. 1st Sh. I. 1st Tr. E. 3rd Sh. I. 1st Sh. E. 2nd Ec. R. 3rd Sh. E.	6 32 7 32 8 26 8 27 9 38 10 40 11 16 11 50 12 24 30 13 8	7 47·1
Sun	8			1st Oc. D. 1st Oc. R.	5 42 9 2 37	7 43·2
Mon	9	15 56 17 17	Occultation of σ Leonis (5) Reappearance of ditto	1st Tr. E. 1st Sh. E. 2nd Sh. E.	5 7 6 19 7 10	7 38·2
Tues	10					7 35·3
Wed	11					7 31·4
Thur	12	3 47	☾ Moon's Last Quarter			7 27·5
Fri	13			1st Oc. D.	13 5	7 23·6
Sat	14		Sidereal Time at Mean Noon 19h. 35m. 23·75s.	2nd Oc. D. 3rd Tr. I. 1st Tr. I. 1st Sh. I. 3rd Tr. E. 1st Tr. E. 1st Sh. E.	9 59 10 14 10 18 11 33 12 11 12 31 13 45	7 19·7

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Jupiter.
Sun	15		Illuminated portion of disc of Venus=0″·989 Illuminated portion of disc of Mars=0·982	1st Oc. D. 1st Ec. R.	7 33 10 58 33	— 7 15·8
Mon	16		Sun's Meridian Passage 10m. 4·15s. after Mean Noon	1st Sh. I. 1st Tr. E. 1st Sh. I. 1st Tr. E. 1st Sh. E. 2nd Sh. E.	6 2 6 59 7 11 7 21 8 14 9 49	7 11·9
Tues	17			1st Ec. R.	5 27 36	7 8·1
Wed	18	16	Conjunction of Moon and Venus 4° 13′ S.	3rd Ec. D. 3rd Ec. R.	5 18 1 6 55 6	7 4·3
Thur	19	4 35 23	● New Moon Conjunction of Moon and Mercury 6° 47′ S.			7 0·4
Fri	20					6 56·6
Sat	21			1st Tr. I. 1st Oc. D.	12 10 12 28	6 52·9
Sun	22			1st Oc. D. 1st Ec. R.	9 26 12 58 30	6 49·1
Mon	23			1st Tr. I. 2nd Tr. I. 1st Sh. I. 1st Tr. E. 2nd Sh. I. 2nd Tr. E. 1st Sh. E. 2nd Sh. E.	6 39 7 16 7 57 8 51 9 50 9 54 10 9 12 28	6 45·3
Tues	24		Saturn's Ring: Major axis=41″·12 Minor axis=12″·89	1st Ec. R.	7 23 33	6 41·6
Wed	25	19 44 10 22	☽ Moon's First Quarter Saturn at quadrature with Sun Conjunction of Moon and Saturn 5° 10′ S.	3rd Oc. R. 2nd Ec. R. 3rd Ec. D. 3rd Ec. R.	5 51 6 54 4 9 19 42 10 57 26	6 37·8
Thur	26	13 0 13 34 13 4 13 52 16	Occultation of ρ^2 Arietis (6) Reappearance of ditto Occultation of ρ^3 Arietis (6½) Reappearance of ditto Conjunction of Moon and Jupiter 2° 45′ S.			6 34·1
Fri	27					6 30·4
Sat	28					6 26·7
Sun	29	12 46 13 18 19	Occultation of ζ Tauri (3½) Reappearance of ditto Conjunction of Moon and Mars 5° 15′ N.	1st Oc. D.	11 20	6 23·0
Mon	30	10 52 12 6 11 43 12 46	Occultation of 16 Geminorum (6) Reappearance of ditto Occultation of ν Geminorum (4½) Reappearance of ditto	1st Tr. I. 2nd Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E. 1st Sh. I. 2nd Tr. E.	8 32 9 51 9 52 10 45 12 5 12 29 12 30	6 19·3
Tues	31	13 28 14 14	Occultation of B.A.C. 2432 (6½) Reappearance of ditto	1st Oc. D. 1st Ec. R.	5 49 9 19 31	6 15·7

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Oct, 1881.
Campbell, Sir A. C.
Fisher, J. S.

To Dec., 1881.
Court, J. M.

To Jan., 1882.
Harley, R.

To March, 1882.
Elliott, R.
Gray, T. P.

To June, 1882.
Groth, Dr.

To Dec., 1882.
Arcimis, A. T.
Barber, J. L.
Clermont, Lord
Clegram, W. B.
Collingwood, E. J.
Davies, Rev. R. P.
Hankey, H. H.
Hunt, G.
Jefferies, J.
Knott, G.
Lee, J.
Lettsom, W. G.
McCance, J. L.
Numsen, W. H.
Parnell, J.
Perry, Rev. S. J.
Redpath, H. S.
Richards, E. M.
Slack, H. J.
Smyth, Prof. P.

To Jan., 1883.
Hutchings, Rev. R. S.

TO CORRESPONDENTS.

All communications should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 230. FEBRUARY. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1881—82.

Last Meeting of the Session, January 13th, 1882.

J. R. Hind, Esq., *President*, in the Chair.

Secretaries—J. W. L. Glaisher, Esq., and W. H. M. Christie, Esq.

The minutes of the preceding meeting were read and confirmed. Mr. Christie announced the receipt of 75 presents since the last meeting.

Harry Escombe, Esq., Durban, Natal,
Major E. S. Gordon, R.A., Royal Carriage Department, Royal Arsenal, Woolwich,
T. Hands, Esq., B.A., 19, Castle Street, Carlisle,
J. N. Harrison, Esq., Saling Grove, Braintree, Essex,
Alfred Morris, Esq., C.E., Sydney, New South Wales,
Samuel H. Parkes, Esq., King's Norton, Worcestershire,
G. E. Ranken, Esq., B.A., 4, Philbeach Gardens, South Kensington, S.W.,
I. Roberts, Esq., Kennessee, Maghull, Liverpool,
Capt. M. Salt, 48, Clifton Hill, St. John's Wood,
Rev. W. J. Wilby, B.A., H.M.S. "Champion," Pacific Station,

were balloted for, and duly elected Fellows of the Society.

Mr. Christie read several papers giving accounts of observations

The displacement of the F or *b* line has been measured in the spectra of 64 stars, nine of which have not previously been observed. Photographs of the sun have been taken on 173 days; these have been measured in duplicate, and the heliographic latitudes and longitudes of the spots have been deduced. At Mr. Huggins's observatory a photograph was secured of the more refrangible portions of the spectrum of comet *b*; the head of the comet was brought upon the slit, and afterwards through the other half of the slit a spectrum of Arcturus was taken for the purpose of comparison. The continuous spectrum could be traced from about F to a little beyond H; in this continuous spectrum were distinctly present G, *h*, H, K, and several other of the Fraunhofer dark lines, showing that the principal part of the light of the comet was due to reflected solar light. There were also two groups of bright lines corresponding to similar groups seen in the spectra of some carbon compounds. Some attempts have been made in the past year to apply photography to the spectra of some nebulæ, but hitherto without success. At Mr. Common's observatory photographs of comet *b* were obtained on several nights. Encke's was found on August 27th, and the satellites of Mars, Phobos and Deimos, were observed on the 27th of December, and their positions measured. At Birr Castle Observatory, Parsonstown, determinations of the radiant heat of the moon have been made on several nights.

Only one minor planet has been discovered during the year 1881; this was discovered by Herr Palisa, at the Observatory of Vienna, on May the 19th. From an interesting research by Herr Hornstein, it appears probable that all the largest of the minor planets have now been discovered, and of those having a diameter exceeding 25 geographical miles the number is extremely small. It seems that the number of asteroids which have been already discovered, having a diameter less than five miles is also very small, especially in that portion of the minor planet zone nearest to Mars. In the outer zone nearest to Jupiter there may be a more considerable number of these minute bodies, probably too faint to be observed by the telescopes ordinarily employed in the search for minor planets. Omitting the few of comparatively large magnitudes the general average diameter of the remaining members of the group, appears to be between five and 15 miles—a much smaller diameter than has hitherto been assumed.

Seven comets have appeared during the year 1881. The first was discovered by Mr. Lewis Swift, of Rochester, New York, on the night of April 30th. The second by Mr. Tebbutt, on May 22nd. This was the first of the two large comets which were everywhere observed in the northern hemisphere. The third by

Schäberle (known as comet *c*) was discovered on the night of July 13th, at the observatory of Ann Arbor, U.S.A. The fourth was Encke's comet. By the aid of the ephemeris calculated by M. Backlund, of Pulkowa, it was detected at Strasburg by MM. Winnecke and Hartwig on the night of August 20, and by Tempel at Arcetri on August 21st. The fifth, a small comet discovered by Mr. Barnard at Nashville, Tennessee. The sixth an interesting periodical comet discovered on the morning of October the 4th by Mr. Denning. It is found to move in an elliptic orbit, with a period of 3070·7 days; the orbit of this comet passes near to the orbits of Venus, the Earth, and Mercury, and it will, therefore, probably be affected by considerable perturbations. The seventh comet was discovered on November the 16th by Mr. Lewis Swift.

In addition to these seven comets a faint object, supposed to be a comet, was noticed on May 12 by Mr. Barnard, of Nashville, Tennessee, near α Pegasi. It was again seen on the following night, but though carefully looked for at several American observatories no trace of it could be found afterwards. Thus the Americans have the credit of the discovery of four out of the seven comets of 1881, besides the last-mentioned object.

The report also contains paragraphs referring to the Cape Catalogue for 1880, Prof. Newcomb's "Standard Stars," the Smithsonian "Report on Astronomical Observatories," "Physical Observations of Jupiter," Prof. Hall's "Observations of Double Stars," "Universal Time and the Selection of a Prime Meridian," and the volume of "Observations of the Total Eclipse of 1878, July 29," published by the United States Naval Observatory.

The President then proceeded to deliver his address, on presenting the gold medal of the Society to Mr. David Gill, for his heliometric observations of Mars at Ascension, and the discussion of his results. The President said: I have now the pleasant duty to state to you the general grounds upon which your Council have felt justified in awarding the Society's medal this year to Mr. David Gill. The planet Mars has occupied no inconsiderable place in the successive attempts at the solution of the grand problem of the determination of the earth's mean distance from the sun, upon which depend all measures of absolute distance and dimensions beyond our moon. The earliest real approximations to the value of the solar parallax were obtained, as is well known, in 1672; through the intervention of this planet, which, in the summer of that year was at one of its close oppositions, and therefore most favourably situated for the object in view. The first of the Cassinis had perceived the advantage that might be taken of the near approach of Mars to the earth to ascertain

the amount of his parallax and thence of the sun's parallax, by comparing observations made simultaneously, or nearly so, at distant points upon the earth's surface; and accordingly, when Richer was sent on the astronomical expedition to the island of Cayenne, in French Guiana, in 1672, it was arranged that observations of this planet should be specially made for comparison with others to be made at Paris. In Cassini's memoir on this subject, he refers to several methods of utilizing observations of Mars for the determination of the sun's parallax, one of which is now commonly known as the meridional method, while another corresponds in principle with that which we are accustomed to term the diurnal method. By the meridional method, or by comparisons of the meridional altitude of Mars at Cayenne and Paris, he inferred that the solar parallax was $9\frac{1}{2}''$. It is gratifying to us, as Englishmen, that this important advance in the knowledge of the solar parallax, from the exceptionally favourable opposition of Mars in 1672, is not solely due to the French astronomer, but that our countryman, Flamsteed, arrived, quite independently, at nearly the same result. In the history of his own life he tells us that "whilst he was inquiring for the planet's appulses to the fixed stars by the help of Necker's ephemeris," he found that in September, 1672, the planet Mars, then newly passed his perihelion, and opposition to the sun, would pass amongst three contiguous stars in the water of Aquarius, and that, by reason of his then being very near the earth, this would be the most convenient opportunity that would be afforded for many years for determining his parallax. A notice which he sent to Oldenburg, was printed in the *Philosophical Transactions* of August 19, 1672, and he further states that Oldenburg having sent his admonition into France, the gentlemen of their Academy took care to have it observed; but we have seen that there was independent action in France. Flamsteed nearly missed the opportunity of contributing to the knowledge of the sun's distance, being called away from home on the very day when he had designed to begin his observations, but he succeeded in observing Mars with the instruments of his friend Townley, and again on his return to Derby; these observations are to be found in the "Historia Cœlestis;" he concludes, therefrom, that the sun's horizontal parallax could not be more than $10''$. On many occasions during the last two centuries the planet Mars has been observed for the purpose of investigating the solar parallax, usually on the meridional method, without any result that could be properly considered as at all definite. Mr. Gill remarks that about a year after the last transit of Venus, when observers began to compare notes and attempts were made to select corresponding

phases at the contacts, a doubt began to arise in the minds of many astronomers whether we should not again repeat the experience of the transit of 1769, and find the observations capable of so many interpretations as to preclude the possibility of unprejudiced and final discussion, and that, in consequence, his attention had been directed to the opportunity afforded by the close opposition of Mars in September, 1877, as a means of arriving at an independent determination of the solar parallax. In 1874, in conjunction with the present Earl of Crawford, Mr. Gill had attempted a new method of finding the solar parallax by combining the suggestions of Sir George Airy, as to employing the diurnal method, with those of Prof. Galle, with respect to utilizing the minor planets. The success which attended their observations of the minor planet Juno, at the Mauritius in 1874, induced him to apply to the Earl of Crawford for the loan of the heliometer with which the Juno observations had been made, for an expedition either to St. Helena or Ascension. His request met with a most ready compliance, and in the autumn of 1876 application was made to the Government Grant Committee of the Royal Society, and to the Council of this Society, each of which bodies voted a sum of £250 towards the expense of the expedition. Mr. Gill left England on June 15th, 1877, and reached Ascension on July 13th. No time was lost in erecting the observatory, which was ready for work four days later. The value of the solar parallax Mr. Gill obtained gives the mean distance of the earth from the sun at 93,080,000 miles.

As a piece of admirable work carried to its conclusion with unremitting energy and great zeal, I believe you will concur in the opinion of your Council that Mr. Gill has well deserved the award of the medal. In handing the medal to the Earl of Crawford, as Foreign Secretary, the President said: In transmitting this medal to Mr. Gill I ask you to assure him of the high estimation with which the Royal Astronomical Society regards his energetic efforts in the cause of the science to which we are devoted, and to express our earnest wishes that continued health may enable him to apply them to the wide field which is open to him as Her Majesty's Astronomer at the Cape, with equal discrimination and as great success as heretofore.

The Earl of Crawford said: Mr. President, it has been my pleasing duty on several occasions to receive a medal, but it has always been on behalf of a foreigner, and to be transmitted abroad. The Society has to-day, however, awarded it to a British subject, and instead of sending it to the British ambassador to be forwarded to the recipient, it will, I presume, be my duty to forward the medal to Mr. Gill's official superior at the Admiralty.

Mr. De La Rue said: I have been entrusted with a resolution which I have great pleasure in proposing. It is that the report now read be received and adopted, and that it be printed and circulated in the usual manner. All of us know that we are indebted to the ability and zeal of our Secretaries for the value of the report which has been presented. (Hear, hear.) We have had a few extracts read from it which makes us all the more anxious to be able to read it in detail. I am sure, therefore, this part of my proposal will be heartily acceeded to. Another proposal I have to submit is this, that it be printed together with the President's Address. The President has most lucidly and comprehensively placed before us the grounds on which the award of the gold medal has been made, and I am sure you will all concur with me that the President's Address should accompany the report. (Applause.) I must add a few words, and they are these: it must be particularly agreeable to Lord Crawford to be the recipient of this medal in order that he may transmit it to Mr. Gill, because Mr. Gill's first astronomical work was performed in Lord Crawford's observatory. Mr. Gill there worked most assiduously with the instruments which Lord Crawford was good enough to place at his disposal for determining the solar parallax.

Lieut.-Col. Tupman seconded the proposal that the report be received and adopted, printed and circulated, together with the President's Address.

The motion was unanimously carried.

Mr. R. J. Lecky said: I regret that the rules of the Society do not permit the mentioning of another name in connection with Mr. Gill's, I mean the name of his amiable wife, who was his efficient coadjutor in these observations, and was the authoress of the very charming book describing the expedition.

Mr. Lecky then read the auditors' report, which was handed in.

Mr. Esdaile proposed, and Mr. Neison seconded, a resolution that the report of the auditors be printed and circulated together with the report of the Council. The resolution was carried.

Mr. Ranyard said: Mr. President, before we proceed to the election of the Council and Officers of the Society, I wish to say that I much regret the absence of Major Herschel's name from the Council-list. I wish to draw attention to the fact, because the absence of his name is due to a mistake. Mr. Christie stated to the Council that Major Herschel was expected to be absent from England the greater part of the year, and I think I may say that in consequence of that statement he was not re-elected by the Council. It turns out, however, that he is only going to be

absent in America for about a month, and I wish to propose that his name should be restored to the Council-list. (Cries of "Order.")

The President: I do not wish to interrupt you, Mr. Ranyard, but I am afraid that what you are proposing is not in order.

Mr. Ranyard: Is not this, Mr. President, the meeting at which we have to elect the Council and Officers for the coming year? I wish to speak upon the subject and to make a suggestion which I believe I have a right as a Fellow to do. I do not intend to say anything which will be personal or unpleasant. Major Herschel's name cannot be restored to the body of the Council, for the by-laws direct that there must be four new members of Council elected each year. This has been accomplished on the present occasion by bringing down the names of two Vice-Presidents and one Secretary to the body of the Council, and there is only one really new member of Council. This is, no doubt, quite correct according to the letter of the by-laws; but I wish to point out that we must not restore Major Herschel's name to the body of the Council in place of any one of these new members, or there would not be four changes. Such lists would not comply with the conditions of the by-laws, and would not be counted. Major Herschel's name cannot be put in without taking out somebody else's name. I therefore propose that we should make him a Vice-President, in place of Professor Smith, who is known to us all as an eminent mathematician, and as one of the ablest members of the Endowment party, but as far as I know he has never contributed any paper to this Society. (Cries of "Oh!") I do not wish to say anything against Prof. Smith, for I believe him to be one of the most honest and able members of his party; but I wish to state that I intend to remove his name from my list, and to replace it by the name of Major Herschel, and I shall be glad if others will do the same.

The meeting immediately broke up, and proceeded to ballot for the election of Officers and Council. The following gentlemen were declared to have been elected:

President.

E. J. Stone, Esq., M.A., F.R.S., Radcliffe Observer.

Vice-Presidents.

J. C. Adams, Esq., M.A., LL.D., F.R.S., Lowndean Professor of Astronomy, Cambridge.

W. H. M. Christie, Esq., M.A., F.R.S., Astronomer-Royal.

J. R. Hind, Esq., F.R.S., Superintendent of the *Nautical Almanac*.

H. J. S. Smith, Esq., M.A., LL.D., F.R.S., Savilian Professor of Geometry, Oxford.

Treasurer.
Francis Barrow, Esq., M.A.

Secretaries.
J. W. L. Glaisher, Esq., F.R.S.
E. B. Knobel, Esq.

Foreign Secretary.
The Earl of Crawford and Balcarres, F.R.S.

Council.
Sir G. B. Airy, K.C.B., M.A., LL.D, D.C.L., F.R.S.
James Campbell, Esq.
Arthur Cayley, Esq., M.A., LL.D., D.C.L., F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge.
A. A. Common, Esq.
G. H. Darwin, Esq., M.A., F.R.S
A. M. W. Downing, Esq., M.A.
Edwin Dunkin, Esq., F.R.S.
William Huggins, Esq., LL.D., D.C.L., F.R.S.
George Knott, Esq., LL.B.
Albert Marth, Esq.
Edmund Neison, Esq.
A. Cowper Ranyard, Esq., M.A.

THE LUNAR RILLS (CLEFTS).

(Continued from page 39.)

No.
69 and 70. — 5° — 44°. 19 miles. 12h. Two closely juxtaposed clefts, only 1·4 miles apart, 5,100 to 6,400 feet wide. The *Mappa Selenographica* erroneously represents them as ridges.

71. — 6° — 48°. (33 miles probably, but the type is here imperfect, and the value given has been deduced from the optical length.) 3h. A cleft-like gap in the wall of *Maginus*, a thoroughly-shattered ring-mountain. There are 4 separate sections, each from 3 to 6 miles in length, which connect 5 minute craters, the largest of which stands at the northern end.

72 and 73. — 21° — 52°. 25 and 16 miles. 12h. Two short transverse clefts in the wall of *Longomontanus*. Each of them ends in a minute crater at the inner foot of the wall. Rarely visible, and only with extreme difficulty. In the

most southerly regions of the moon, between *Schickard* and *Inghirami*, as well as in the neighbourhood of *Wargentin*, there are numerous small valleys, which present appearances closely akin to those of clefts; namely, *Schickard* θ, η, ζ, and *Wargentin* δ. But it is easy to convince oneself that only extreme foreshortening gives them this aspect.

74. + 4° — 84°. 12 miles. 12h. The most southerly of all the clefts hitherto seen. It passes from the wall of a small ring-mountain to that of a crater, and is perceptible only when the moon is near quadrature, and has at the same time considerable northern latitude.

75. — 28° — 65°. 15 miles. 12h. Extremely difficult, on account of its high latitude and the wildly-disturbed landscape. In the middle of its brief course two small rounded enlargements are indistinctly visible.

76. + 34° — 1°. 28 miles. 9h. Curvature very slight. Extending at the foot of a gentle hill, it connects two higher mountains.

$\left.\begin{array}{l}77.\\78.\\79.\end{array}\right\}$ + 37° — 3°. $\left\{\begin{array}{l}83 \text{ miles.}\\75 \text{ ,,}\\60 \text{ ,,}\end{array}\right\}$ 8h. Three slightly-curved clefts, which, nevertheless, retain their parallelism, about 3,200 feet in width. The most easterly and longest of them passes without interruption along a range of hills, the latter half of it lying in a plain; at both ends stand knob-like mountains. The second (Capella η) is interrupted midway for a short distance (about 1·4 miles) by a small mountain; the third (ζ) for a somewhat greater distance, by the same mountain. After its reappearance it traverses two very minute craters, and ends at a larger one.

80. + 39° — 7°. 15 miles. 9h. Not a true cleft, but an intimate union of 6 recognisable very minute craters, which are discernible as such only under exceedingly favourable circumstances. The craters seem to diminish in size from north to south. Straight.

81. — 40° — 1°. 39 miles. 8h. in northern, 9h. in the southern portion; the former only being a true cleft, while the latter is broader and shallower, so that it comes to an undecided termination in the plain. Two similar but shorter valleys which present nearly the same aspect (with 81), extend parallel to one another in a westerly direction from it; the intervening hills nowhere attain a considerable height.

82. + 42° — 7°. 34 miles. 11h. Extending in a straight line from a hill to a crater, through a level but bright landscape. Not easily seen.

83. + 41° —7°. 35 miles. 9h. East of, and parallel to the preceding (82). Almost straight. It is directed towards the same crater, but seems not to reach it. The district (is) a level (one).

84. + 41° — 8°. 40 miles. 9h. East of the former, and parallel to it. It cuts off a bay-like portion of the *Mare Fœcunditatis*, and extends from mountain to mountain (*i.e.*, from cape to cape).

85. + 44° — 9°. 24 miles. 9h. Curvature scarcely perceptible. Extending from the wall of *Gœlenius* to a bright hill through a level dark district. Near its centre a low ridge approaches the cleft nearly from the northward, and it appears to be here somewhat widened.

The clefts (76)-(85) all occur within a triangular area including about 15,200 square miles, which also comprises within it a multitude of crater-rows, chains of hills, and shallow valleys, all arranged in the assigned and nearly parallel directions. They are, without exception, very delicate objects, and visible only under favourable circumstances; but when these occur the landscape developes a truly astonishing abundance of the most widely-differing forms, whose delicacy and sharpness of delineation render this spectacle charming in the highest degree. We were but slightly acquainted with them, although we had repeatedly observed them, when, on the 24th of July, 1834, they displayed themselves in their full magnificence.

86. + 6° — 10°. 55 miles. 11h. A cleft-like valley with frequent bends, in breadth about 9,600 feet, extending its whole length between lofty peaks; yet the curvatures are but slight and insignificant. The southern end opens into a plain, the northern debouches into a deep ring-mountain.

87. + 4° — 16°. 28 miles. 11h. Very similar to the foregoing. Its northern end opens into the plain (in the centre) of *Parrot;* at its southern an intimately-united series of three craters prolongs it for 14 miles; upon this follows a little hill, and next there opens a plain. A minute branch joins it from the north-west.

88. 0° — 15°. 46 miles. 11h. Related to (87) and (88), only the surrounding mountains are less lofty, and the cleft is somewhat narrower.

89. + 14° — 15°. 56 miles. 9h. This remarkable cleft or

crater-chain begins at a lofty peak in the eastern part of the wall of *Abulfeda*. First come two closely-united craters, and then five others connected together by short sections of the cleft; the last of them is remarkably bright, and has a high wall. The cleft now proceeds with tolerable uniformity for 28 miles, an eighth, and, immediately afterwards, a ninth and larger crater succeeding thereto. The first five craters may be considered as belonging to the outer wall of *Abulfeda*, the last to that of *Almanon*. The whole formation is straight.

90. + 28° — 27°. 77 miles. 8h. In the western part (it lies) between lofty mountains, and is also closely-surrounded by numerous craters, though not visibly connected with any of them. In its eastern portion it traverses a level country, at the same time growing narrower, and losing itself insensibly. Straight. It continues at a distance of about 18 miles from the foot of the lofty wall of *Piccolomini;* if produced, it would meet it at right angles.

91. + 28° — 28°. 18 miles. 11h. Enters the last-mentioned from the southward, at an angle of about 40°. On the west (there is) a high mountain, but on the east it is more level. Somewhat curved.

+ 58° — 25°. 29 miles. 2h. Begins near the central mountain of *Petavius* with an unequal breadth—probably also varying in depth,—and traverses the upheaved bowl-shaped interior of *Petavius.* On both sides it is accompanied by hills (and) shines brilliantly. About 3 miles from the foot of the wall it comes to an end, or ceases to be visible.—We have once detected it, indeed, at full, as a delicate bright line, when no trace of *Petavius* was visible.

REVIEWS.

Account of Observations of the Transit of Venus, 1874, December 8, made under the authority of the British Government: and of the reductions of the observations. Edited by Sir George Biddell Airy, K.C.B., Astronomer-Royal. Printed for H. M. Stationery Office under the authority of the Lords Commissioners of the Treasury. 1881. Pp. 512—21, with plans and diagrams.

Of the invaluable services of Captain (now Colonel) Tupman in the examination and reduction of these observations, the Astronomer-Royal in the Introduction says, "Never, perhaps, was such an enormous mass of calculations so severely criticized, and, where necessary, repeated." When the work was brought up to a certain point Captain Tupman was obliged to quit the country, and Sir George Airy says, "Though anticipating for myself a heavy addition to the labours of an office already

sufficiently oppressive, I could but feel grateful to Capt. Tupman for the disinterested zeal—I may call it heroic—with which he had laboured to bring the work to that point."

The places of observation, and the chiefs of the observing parties were as follows: 1. Hawaiian (Sandwich) Islands, Capt. G. L. Tupman, R.M.A. 2. Egypt, Capt. C. Orde Browne, late R. Artillery. 3. Island of Rodriguez, Lieut. Charles B. Neate, R.N. 4. Kerguelen Island, Rev. S. J. Perry, F.R.S. 5. New Zealand, Major H. S. Palmer, R. Engineers. The Appendix, among other things, relates to photographic operations, which, after laborious measures and calculations, proved unsuccessful, the principal cause being that "however well the sun's limb on the photograph appeared to the naked eye to be defined, yet on applying to it a microscope it became indistinct and untraceable, and when the sharp wire of the micrometer was placed on it, it entirely disappeared." The photographs are carefully preserved at the Royal Observatory. As to the results of the observations, the Astronomer-Royal says, "I have endeavoured to give the equations in the shape which will admit of combination in the easiest way for the computer's further operations—(whether he may desire to use the Calculus of Probabilities for the whole, or to make any special selection of combinations)—when he shall have decided on the recorded phase of contact of limbs which he thinks best to adopt."

The disc of Venus outside the limb of the sun before internal contact at ingress, was seen by Prof. G. Forbes at Kailua (Sandwich Islands), by Mr. R. Johnston and the Rev. R. Dunn at Waimea (ditto), by Lieut. C. B. Neate (who failed to see it at egress), at Point Venus, Rodriguez. He says, "Instantly when I saw the notch on the sun's limb, I also saw the remaining segment of the planet showing in strong relief against the dark space beyond, and surrounded by an *exceedingly* faint annular haze. The following limb of the planet also appeared bright, like a very young moon." Fig. 1., plate xiii. Commander William J. L. Wharton, R.N., at Point Coton, Rodriguez, observed the outer limb of Venus farthest from the sun, illuminated, and at the same time saw "a distinct cone of shadow thrown into space, but for no great distance, on the line joining centres of sun and planet." He gives a diagram of this. He also saw the limb of Venus outside the sun at egress. Lieut. R. Hoggan, R.N., at Hermitage Island, Rodriguez, noticed the part of the disc of Venus outside the sun's limb as of a reddish brown colour, whilst the part entered on the sun's disc was intensely black. At egress he remarked the same reddish brown colour, and shortly afterwards noticed that "its outer limb became faintly illuminated with a yellow light, presenting something of the appearance of a very young moon with her horns directed towards the sun's limb." Of this he gives a diagram. He adds, "The portion of the planet outside the sun's limb retained the same appearance in regard to colour and illumination of the outer limb up to within a few moments of external contact." External contact was accidentally missed, and the planet, which had passed off the sun's disc, could not be seen any more. Lieut. Cyril Corbet, R.N., at Supply Bay, Royal Sound, Kerguelen Island, saw the following limb of the planet outside the sun, which he describes as of a steady brownish-white light, with black speckles here and there, like irregularities on the planet's surface, quite distinct."

As specimens of the accuracy of observations, we may instance the longitude of Honolulu station; by the meridional transits of the moon, 10h. 31m. 26·0s. W.; by the zenith distances of the moon, 10h. 31m. 27·3s.; by the occultation of stars, 10h. 31m. 26·9s. The co-latitude by a mean of north and south stars, zenith distances 15° to 60°, is 68° 42′ 3″·54; zenith distances 60° to 70°, 68° 42′ 2″·84; zenith distances 70° to 81°

$68^\circ\ 42'\ 2''\cdot77$, the mean being $68^\circ\ 42'\ 3''\cdot14$. The longitude of Point Venus, Rodriguez, by meridional transits of the moon is 4h. 13m. $42''\cdot11$s. By the zenith distances of the moon, 4h. 13m. 43·05s.; by the occultations of stars, 4h. 13m. 42·52s. The preliminary longitude obtained by Lord Lindsay [Lord Crawford] by the transportation of 42 chronometers between that station and his observatory at Belmont, Mauritius, was 4h. 13m. 43·0s. The co-latitude from 59 stars north of the zenith is $70^\circ\ 19'\ 38''\cdot2$. From 28 stars south of the zenith, $70^\circ\ 19'\ 37''\cdot6$.

The principal makers of the instruments used in these expeditions are Messrs. Dent and Co. and others, clocks; Messrs. Troughton and Simms, transit instruments, altazimuths, telescopes, reflecting circle, micrometers; T. Cooke and Sons, equatorials, transit instruments, etc.; Dollond, telescopes; Browning, spectroscopes; Dallmeyer, equatorial; C. Frodsham and others, chronometers; Casella, barometers, &c.; Horne and Thornthwaite, barometers, etc. Capt. C. O. Browne observed with the Lee equatorial by Tulley, used by the late Admiral Smyth, which was purchased by the Government expressly for the transit of Venus. We record with pleasure the names of two ladies who assisted in the Egyptian observations: Mrs. Browne, who counted the seconds from the clock, and Miss E. M. Newton, who observed the transit of Venus with her brother, Mr. F. M. Newton.

It is evident that all the observers did their best, sometimes under difficult and discouraging circumstances, but no weak point seems to have escaped the vigilant scrutiny of the Astronomer-Royal and his able deputy, Capt. Tupman. The result, however it may have fallen short of expectations, must be a valuable contribution to the general approximate solution of the great problem when the published observations of the observers of the other nations shall be available for its discussion. To the few, comparatively, who will make use of the final equations, this fine volume will be of great importance, but it cannot fail to interest much all astronomical readers into whose hands it may fall, though probably not very many are in a condition adequately to appreciate the amount of skill and labour which it represents.

It will be remembered that the resulting solar parallax was found by the Astronomer-Royal to be $8''\cdot760$, and subsequently by Capt. Tupman, by another discussion of the observations, $8''\cdot846$. (See *Astronomical Register*, Vol. XVI., p. 177; *Observatory*, Vol. I., pp. 149 and 166.)

The Dimensions of the Stellar Universe. A Paper read before the Literary and Philosophical Society of Liverpool, November 15th, 1880. By R. C. Johnson, F.R.A.S.

We have read this paper with interest, and we think that Mr. Johnson has condensed much information in a plain and useful manner. Such papers may interest a wide circle of readers as well as hearers, and are calculated to be very useful.

Oxford University Observatory. From the Annual Report of the Savilian Professor of Astronomy to the Board of Visitors, June 14th, 1881.

Amongst the multifarious work which occupies the Professor we see that the laborious and difficult researches on the Nutation of the Moon's Axis of Rotation have been successfully concluded, and the details will soon be ready for publication. A definite and reliable orbit of a binary star has been obtained by a method devised by Prof. Pritchard five years ago. The exact relative positions of a group of 280 stars near the

Milky Way have been ascertained for the astronomy of the remote future. It is proposed to employ Mr. Jenkins in accurately triangulating the moon's surface. We rejoice to find that by his lectures, and in other ways, Prof. Pritchard aims at giving the widest range to the educational advantages of the observatory, and diffusing a knowledge of astronomy, not only among the members of the University, but those outside of it. He acknowledges the zealous aid afforded by his highly informed and experienced assistants.

The Total Solar Eclipse of July 29, 1878,—*Observations at Pike's Peak, Colorado.* Report of Prof. S. P. Langley.

Untoward circumstances prevented Prof. Langley from carrying out his full programme of observations. At an elevation of 10,000 feet there were no physical drawbacks, and there was great purity of atmosphere; but at 14,100 feet (the summit of the Peak) the physiological conditions and the sky were both unfavourable. Indeed, Prof. Abbe was obliged at last to be carried down to a lower altitude. Great difficulty of breathing, increased action of the heart, constant and severe headache, and nearly every symptom which attends sea-sickness, were experienced by Prof. Langley and his brother, Mr. John W. Langley, during a week of discomfort on other accounts besides. For instance, Prof. Langley found, on waking one morning, the snow ten inches deep beside him. As to illness, the worst was over when it was time to go. On the morning of the eclipse, happily, the sky was almost cloudless, and of a deep transparent blue, never seen near the Atlantic coast. The sketches of the corona given exhibit a narrow ring of vivid light, fading with great suddenness into a nebulous luminosity rudely circular in the outline of the faintest part, but with two wings, or extensions, of extraordinary length, making an angle of 45° with the vertical; the one to the right extending about 3½ solar diameters, and the other on the left to fully 12 diameters. This latter was considerably more than a solar diameter in width, and though perhaps not so absolutely structureless as the zodiacal light, and longer than that in proportion to its breadth, Prof. Langley says he should compare it to the zodiacal light with more confidence than to anything else, and he can confidently assert that the 12 diameters through which he traced it *were but a portion of its extent.* After the above naked-eye observations, only four or five seconds remained for telescopic scrutiny, which yet afforded the Professor "a surprisingly definite filamentary structure, . . not disposed radially, . . sharpest and much the brightest close to the disc, fading away rapidly into invisibility at a distance of five minutes of arc or more (perhaps in some cases of ten)." A memorial sketch of this appearance is given, which shows the lines not straight, but generally curved, and curved in different directions. The corona (protecting the eye from direct sunlight) remained visible for over four minutes after totality. Though the naked-eye sketch was made in ignorance of the apparent direction of the ecliptic, upon subsequent reduction the axes of the longest ray coincided, as far as determinable, exactly with the ecliptic trace.

Photometric observations made, by Prof. John W. Langley, resulted in ascribing to the coronal light, about one minute from the limb of the moon, a value of 132 ten-millionths that of mean sunlight, and assuming mean sunlight to be 500,000 times that of moonlight (using round numbers) the corona, at one minute from the moon's limb, was six times the

intrinsic brightness of the moon; at three minutes it was but one-tenth the intrinsic brightness of the moon, and the Professor believes that, in spite of the difficulties of an improvised apparatus, the above values, though not final, yet are very useful approximations to the truth.

Just before the shadow fell on the clouds, Mr. C. S. Shields describes the approach of totality as heralded by a bright yellow light all over them, passing into orange, pink, rose red and dark red, in a few seconds. This was followed by the blue-black shadow. Several others saw this brief but splendid spectacle. The colours were described as being comparable in vividness to those of a bright sunset. It seems to have lasted less than ten seconds.

To this report are also appended letters of interest from Mr. E. V. McCandless and Mr. W. B. Manning, who assisted at the observations. This brief notice of Prof. Langley's valuable report will show, that though disappointed in his hope of seeing the corona before the day of the eclipse (which he thinks worth trying for again under more favourable conditions), the trouble and hardships of the expedition, which would evidently have been too great for constitutions less vigorous than his own and his brother's, were repaid by a view of the development of the coronal wings to an unexpected extent, and the satisfactory results of photometric observations on the corona, made for the first time under many disadvantages. The paper is, therefore, a valuable addition to the comparatively little we yet certainly know of this wonderful phenomenon. And the expedition furnishes, besides, some useful information about the conditions of vision on mountain summits. These peaks condense the moisture, and cover themselves with clouds when it is clear below, so that a lower station sheltered by a mountain range from the vapour-bearing winds is much better than the peak itself. Speaking from his limited experience on Pike's Peak, Prof. Langley says that the best station will "very probably prove to be at a high altitude, but not above the" timber line, "or at from eight to eleven thousand feet, with still higher ground beyond toward the source of the prevalent winds."

In Nos. 9 and 10 of *Copernicus,* for September and October, 1881, amongst other interesting articles, there is one by D. T. Todd, on the Solar Parallax as derived from the American Photographs of the Transit of Venus, 1874, December 8, 9, the final result of the equations gives the mean equatorial horizontal parallax of the sun $8''.883 \pm 0''.34$, corresponding (adopting the dimensions of the earth given by Colonel A. R. Clarke, *Geodesy*, &c.) to a distance between the centres of the sun and earth equal to 92,028,000 miles. The total number of photographs is 213. Several small corrections that may slightly modify the above conclusion have unavoidably been disregarded for the present. Mr. Denning contributes to No. 10 a paper on Meteor Showers, and there is an account of the meeting of the "Astronomische Gesellschaft," at Strasburg, Sept. 22-24, 1881. Some of our readers may like to be reminded that this valuable international journal is edited by Messrs. Copeland and Dreyer. The subscription in advance, 16s., is payable to J. L. E. Dreyer, the Observatory, Dunsink, County Dublin, and Post-Office orders are to be made payable at the General Post-Office, Dublin.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

STAR MAGNITUDES.

I observe one or two references in the last number of the *Astronomical Register*, more or less applying to observations made or making in the University Observatory, Oxford, and which your readers may consider, require some notice at my hands.

Prof. Pickering gives a list of the star magnitudes of 26 stars in the Pleiades, which he has determined by means of a photometer, at once effective, original, and elaborate. He kindly refers to measures of the same stars now in progress here with an instrument which I have described in the *Monthly Notices* for November last. Prof. Pickering criticizes the difficulties which attend his method, and, in fact, all methods of photometric measuring, and also those which are more or less inherent in the instrument and mode of using it which I have adopted at Oxford. I will not reply to these valuable remarks at present, nor to some other criticisms which my method has received at the hands of M. Lœwy, of the Paris Observatory. I reserve them for the next number of the *Monthly Notices*, by which time it may be hoped that the measures of the Pleiades magnitudes may have been completed, provided only the abnormally wretched weather, for such delicate observations, shall moderate.

Nevertheless, as the subject itself now possesses so great an interest in the mind of many astronomers, and especially as at last affording a hope that an astronomical want of centuries is in course of being supplied, I will so far anticipate what I have to say by giving the results of the Oxford method side by side with those of Prof. Pickering, in respect to 26 stars in the Pleiades. In so doing, perhaps I may be permitted to remark that

1. The two photometric methods are most widely different, and independent of each other.
2. All such observations are attended with many difficulties from many sources, and are delicate in their proper reductions.

Nevertheless, they are ultimately definite and certain, within narrow limits.

Stars Observed.	Difference of Magnitude determined at Harvard.	Difference of Magnitude determined at Oxford.	Harvard —Oxford.	Average Deviation of Oxford Measures.
	mag.	mag.	mag.	mag.
Merope—Alcyone	+1·22	+1·33	—0·11	·02
—Electra	+0·40	+0·45	—0·05	·12
—Taygeta	—0·22	—0·37	+0·15	·05
—Celeno	—1·01	—1·15	+0·14	·09
—18 *m*	—1·41	—1·62	+0·21	·06
—Asterope	—1·49	—1·58	+0·09	·07
—*l* ...	—2·06	—2·12	+0·06	·09
—19 ...	—2·47	—2·54	+0·07	·16
—22 ...	—2·52	—2·51	—0·01	·16
—24 ...	—2·24	—2·24	0·00	·12

The mean average deviation is 0·09 magnitude. This general accordance seems to me to be extremely remarkable, and appears confirmatory of both methods pursued; and, so far as the average deviations of the separate star measures from the mean indicate, the one method seems as trustworthy as the other.

Mr. Gemmell, in your last number, asks a question regarding the magnitude which I have assigned for κ Lyræ. If he will kindly refer to the communication which I made in the *Monthly Notices* of November last, he will find, I think, the reply to his question. But that κ Lyræ has been tolerably stable in its light for three centuries at least, I think is clear from the estimation of its magnitude made by astronomers from Bayer downwards. I have provisionally called it 4·7, *i.e.*, $4\frac{7}{10}$ magnitude, but I have said that, so far as my *relative* photometric measures are concerned, any other magnitude would do as well. With regard to the discrepancies of estimated magnitude which he notices, they are more apparent than real. Argelander 5—4 and Heis 5—4 mean a magnitude 5, tending towards a fourth, but nearer to a fifth. Houzeau gives 4—5. The only real discrepancy lies in Mr. Proctor's estimate; but I think that gentleman would for himself place no certain reliance on the estimate of magnitude 4, which he has given in his star atlas.

Oxford University Observatory: C. PRITCHARD.
1882, Feb. 18.

REGION EAST OF PLATO.

Sir,—In "Selections from the Portfolios of the Editor of the Lunar Map and Catalogue," second issue, two drawings of the region east of Plato are reproduced, one made by Schröter, dated the 9th October, 1788, and the other by the late Mr. W. R. Birt, dated the 29th December, 1873. In the first of these drawings Schröter depicts two craters, which he marks *m* and *n*, the latter, designated "D" in Neison's map, being much smaller than the former. Both the above-mentioned drawings were compared with the moon, by Mr. Birt, on January 27, 1874, and *n* (D) "appeared at least equal to *m*."

Now on turning to Neison's map, it will be seen that the crater *n* (D) is shown very much larger than *m*. In order to ascertain the relative sizes of these two craters at the present time, this region was examined on February 10th, 16h. 30m., with power 150 on a 5¼ in. Calver reflector; and it was found that the relative sizes are more correctly shown in Neison's map, *n* (D) being at least one-third larger than *m;* the difference in size was very striking.

These facts would seem to suggest the idea that Schröter's *n* may have been progressively enlarged, and that this object should be especially deserving of attention in the future.

Yours faithfully,

A. STANLEY WILLIAMS.

West Brighton: February 10, 1882.

Erratum.—P. 45, line 5, for "a deep wall," read "low wall."

BETA CYGNI.

I am much obliged by Messrs. Gemmill and Gore's remarks as to the probable variation of β Cygni. I had never seen Klein's observations, and am glad to supplement them by an independent testimony.

I had intended to request attention to two *possible* varieties among the minute stars strewed over the Great Nebula in Andromeda, but the object had passed away too far while I was otherwise occupied.

Yours faithfully,

Hardwick Vicarage, Hay: T. W. WEBB.

Feb. 14, 1882.

LONGITUDE OF THE MOON'S TERMINATOR at MIDNIGHT.

N.B. — Means East. + West. M., Morning Terminator.
E., Evening Terminator.

1882.	° ′		° ′		° ′
Mar. 1	−54 39 M.	12	− 8 37 E.	23	+37 23 M.
2	66 50	13	20 47	24	25 13
3	79 0	14	32 58	25	31 1
4	+88 49 E.	15	45 8	26	0 50
5	76 39	16	57 20	27	−11 21 M.
6	64 28	17	79 31	28	23 32
7	52 17	18	81 41	29	35 44
8	40 7	19	+86 8 M.	30	47 55
9	27 56	20	73 57	31	60 7
10	15 46	21	61 46		
11	3 35	22	49 35		

☾ in apogee, Mar. 2 ... 23h.
perigee „ 18 ... 1
apogee „ 30 ... 9

LUNAR WORK FOR MARCH, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Cleomedes. On page 19 will be found a catalogue of the objects within this formation; a list is given this month of all the other objects hitherto designated from Cleomedes. There are several other conspicuous craters in this district as yet un-lettered, especially may be mentioned one between *Cleomedes* and *F*, which, although considerably larger than *D*, is yet un-named. It would greatly assist in completing the catalogue of the districts if observers would be good enough to make careful drawings of the region, the outline of which is indicated by the objects in this list, and to verify the positions and distances of these objects.

On Dec. 24, 1881, an observation was made by Mr. A. Stanley Williams (*English Mechanic*, p. 424), of *Cleomedes A* that is worthy of notice. *A* 2 appeared as a very lofty hill (the S.W. wall), casting a large shadow. The pass on the north was visible, but with all attention he could not be certain that *A* was visible. There was a very slightly brighter spot on the north of the hill before mentioned, but there was not the slightest suspicion of its being a crater, no shadow being visible, nor was the very slightly brighter spot of any definite form. *C* 2, *B*, and *i*, were all visible as craters containing shadow. Definition was fair, but very misty. It was this crater *A* that Schröter supposed to have been first newly formed about Oct. 5, 1789. On March 31, 1789, Dec. 2, 1788, and Jan. 29 and 30, 1789, he speaks of observing "a long hill with shadow, with possibly a little unevenness to the east, but no trace of a crater;" which observations singularly correspond with that of Mr. Williams. The moon will be in similar phase on April 21, when it would be well to look for *A*.

Bright Streaks. The following notes of observations may be of interest:

1. In a letter dated Nov. 7, 1865, Mr. Bird, of Birmingham, says: "One thing more I noticed last night, and was much struck by it, viz., the almost spiritual appearance of the luminous ray from *Messier*. *It*

appeared to be suspended over the surface, the objects below being seen through it, even close up to *Messier A.* As the shade crept round and darkened the surrounding surface, on its eastern side, I fancied I could still see the luminous ray suspended above the gloom, although exceedingly faint."

2. Speaking with reference to the above passage, Mr. Birt added, "I have observed now some years since (1865) the delicate rays from *Proclus* to present similar phenomena. The fading away of these rays, as the craters from which they emanate pass with night, is curious."

I should be much obliged for information as to any similar or analogous appearances that observers may have met with.

PLINIUS. The *English Mechanic* of Feb. 3 contains an account of an observation on Jan. 25, from 5h. to 6h. 30m., made by Mr. T. G. Elger, of the floor of Plinius. In it he enumerates among the objects seen—

1. Two large mountains, situated one in the south-east quadrant of the floor, the other in the north-east.
2. Two craterlets on the north-west portion of the floor.
3. A bright region reaching from the centre to the north wall.
4. A range of low hills extending from the centre to the south wall.
5. In the position of the two hills shown by Mädler and Neison in the centre, a large crater with a lofty E. wall, the shadow of which resembles a second crater.

On the same evening M. Gaudibert also observed Plinius and saw two craters lying close together in a S.E. and N.W. direction, about the centre of the floor.

These descriptions so closely agreeing prove the existence of the objects beyond doubt; but they differ sufficiently to make further observation very desirable.

Schmidt in his large map shows the two mountains (No. 1 *above*), and two craters in the centre, each of them having a break in its wall towards the north. He shows a single craterlet in the north-east part of the floor, but neither of those (No. 2) seen by Elger in the north-west. And he gives a single hill close to the south of the two central craters, in place of Elger's "range of low hills" (No. 4). Lastly, he places a single craterlet on the ridge of the south wall, but he does not show Elger's two very small craterlets on the glacis on the S.W., nor the other pair Elger saw on the south. On the other hand he has drawn a series of low hills radiating from the west wall of Plinius, which do not occur in any other map or drawing to which I have access.

CATALOGUE OF CLEOMEDES.

		P.	D.
a	The central peak of the central mountain.		
a 1	The S.E. peak of the central mountain.		
a 3	The N.W. peak of the central mountain.		
D	A crater five miles in diameter.	270°	4·25
D 2	A very small craterlet on the south edge of *D*.		
d	A long irregular walled plain with low walls.	320	2·3
d 2	A crater north-west of Cleomedes.	350	2·2
e	A ring plain 1·15 miles in diameter.	260	1·8
F	A rather bright crater on the north border of the Mare Crisium	200	4·2
k	A valley running into the M. Crisium from *C*.	190	4·0
Γ	A peak (13,352 feet) lat. +21° 10′, long. +50° 0′	180	4·5
γ	A peak at the N. end of curved mountain.	270	2·4

N.B.—The unit of distance is the 124th part of the moon's diameter.

The origin of the measures is the crater *B* on the floor of *Cleomedes.* The distances are measured to the centre of craters, and to the mouth of the valley *k* where it opens on the Mare Crisium.

All the measures are, of course, only approximate, but will serve for the ready identification of the objects.

The unit of distance on the various published maps is very nearly as follows :

Beer and Mädler	3	tenths	of an inch.
Neison	2	,,	,,
Lohrmann	3	,,	,,
Webb	1	,,	,,
Schmidt	6	,,	,,
Birt's Areas	16	,,	,,

It is also very nearly the distance that a point on the moon's surface is carried past a wire in the eyepiece of the telescope by the diurnal motion of the earth in a second of time, when the moon is on the equator, and at her mean distance.

St. Mary's, Bayswater, W. :
Feb. 20, 1882.

THE PLANETS FOR MARCH.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	21 50 41	S. 10 10½	10″·1	23 10·1
	9th	21 49 35	S. 12 13	8″·9	22 37·6
	17th	22 10 8	S. 12 5	7″·7	22 26·6
	25th	22 43 18	S. 10 4½	6″·9	22 28·2
Venus ...	1st	22 59 19	S. 8 2	9″·6	0 22·5
	9th	23 36 15	S. 4 5½	9″·8	0 27·9
	17th	0 12 42	S. 0 2½	9″·8	0 32·8
	25th	0 49 2	S. 4 2	9″·8	0 37·6
Mars ...	1st	6 4 15	N.26 21½	10″·9	7 26·3
	9th	6 14 52	N.26 9½	10″·1	7 5·4
	17th	6 27 11	N.25 54	9″·5	6 46·2
	25th	6 40 54	N.25 34½	8″·9	6 28·5
Jupiter ...	1st	3 11 57	N.17 3½	34″·9	4 34·4
	9th	3 16 57	N.17 25	34″·1	4 8·0
Uranus ...	2nd	11 12 22	N. 6 0	4″·0	12 29·6
	18th	11 9 48	N. 6 16	4″·0	11 24·2

Mercury rises about three-quarters of an hour before the sun, at the beginning of the month, the interval slightly increasing. Towards the end of the month the interval decreases.

Venus sets a few minutes after the sun on the 1st, the interval increasing.

Mars sets about two hours and three quarters after the sun at the beginning of the month, the interval slightly increasing.

Jupiter sets about a quarter of an hour after midnight on the 1st, and afterwards earlier each night.

Saturn sets an hour and ten minutes before midnight, at the beginning of the month, the interval increasing.

ASTRONOMICAL OCCURRENCES FOR MARCH, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage
		h. m.			h. m. s.	h. m. Mars.
Wed	1	11 22 12 15 14 21	Occultation of A^1 Cancri (6) Reappearance of ditto Near approach of A^2 Cancri (6)	1st Tr. I.	10 47	7 29·0
Thur	2	10 27 11 37	Occultation of ω Leonis (6) Reappearance of ditto Sidereal Time at Mean Noon 22h. 40m. 41·82s.	3rd Ec. R. 1st Oc. D. 1st Ec. R.	7 9 1 8 7 11 32 3	7 26·3
Fri	3	5 59 6 27	Occultation of 14 Sextantis (6) Reappearance of ditto Sun's Meridian Passage 12m. 5·74s. after Mean Noon	1st Sh. I. 1st Tr. E. 1st Sh. E. 2nd Tr. I.	6 31 7 30 8 44 9 54	7 23·6
Sat	4	12 39 6 55 8 59 9 31 14 17 15 24	○ Full Moon Near approach of B.A.C. 3726 (6) Occultation of 55 Leonis (6) Reappearance of ditto Occultation of p^2 Leonis (6) Reappearance of ditto	1st Ec. R.	6 1 2	7 18·2
Sun	5		Saturn's Ring: Major axis=38″·50 Minor axis=12″·71	2nd Ec. R.	9 12 56	7 15·6
Mon	6	16	Uranus at opposition to the Sun			7 13·0
Tues	7					7 10·4
Wed	8	15 30	Near approach of B.A.C. 4700			7 7·9
Thur	9			3rd Oc. R. 3rd Ec. D. 1st Oc. D. 3rd Ec. R.	6 37 9 29 26 10 6 11 11 50	7 5·4
Fri	10			1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	7 16 8 27 9 29 10 39	7 2·9
Sat	11			1st Ec. R.	7 56 46	7 0·5
Sun	12	9 27	☾ Moon's Last Quarter	1st Oc. R.	6 54	6 58·0
Mon	13					6 55·6
Tues	14		Sidereal Time at Mean Noon 23h. 28m. 0·45s.	2nd Sh. E.	6 58	Regulus. 10 32·4
Wed	15		Illuminated portion of disc of Venus=0″·996 Illuminated portion of disc of Mars=0·903			10 28·4

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Regulus.
Thur	16	16 15	Occultation reappearance of o^2 Capricorni (6)	3rd Oc. D. 3rd Oc. R.	8 44 10 56	— 10 24·5
Fri	17	5	Conjunction of Moon and Mercury 6° 2′ S.	1st Tr. I. 1st Sh. I.	9 15 10 22	10 20·6
Sat	18		Sun's Meridian Passage 8m. 9·57s. after Mean Noon	1st Oc. D. 1st Ec. R.	6 36 9 52 26	10 16·6
Sun	19	0 17 16	● New Moon Conjunction of Moon and Venus 5° 47′ S.	1st Sh. E. 2nd Oc. D.	7 3 9 39	10 12·7
Mon	20					10 8·8
Tues	21	22	Conjunction of Moon and Saturn 4° 5′ S.	2nd Sh. I. 2nd Tr. E. 2nd Sh. E.	6 58 7 29 9 36	10 4·8
Wed	22	10 10 20	Occultation of 53 Arietis (6) Conjunction of Moon and Jupiter 1° 23′ S.			10 0·9
Thur	23	8 25 9 22	Occultation of B.A.C. 1242 (6) Reappearance of ditto			9 56·9
Fri	24					9 53·0
Sat	25	5 32 6 53 9 47	Occultation of B.A.C. 1835 (6½) Reappearance of ditto Near approach of χ^1 Orionis (4½) Saturn's Ring : Major axis=37″·60 Minor axis=12″·85	1st Oc. D.	8 36	9 49·1
Sun	26	1 33 10	☽ Moon's First Quarter Conjunction of Moon and Mars 5° 39′ N.	1st Sh. I. 1st Tr. E. 1st Sh. E.	6 46 7 59 8 59	9 45·2
Mon	27			3rd Sh. I. 3rd Sh. E.	7 30 9 28	9 41·2
Tues	28	13 27 14 22	Occultation of B.A.C. 2872 (6) Reappearance of ditto	2nd Tr. I. 2nd Sh. I. 2nd Tr. E.	7 37 9 35 10 17	9 37·3
Wed	29					9 33·4
Thur	30	14 55	Near approach of 14 Sextantis (6)			9 29·4
Fri	31	15 11 15 59	Occultation of B.A.C. 3726 (6) Reappearance of ditto			9 25·5
APRIL Sat	1	11 3 11 45 17	Occultation of c Leonis (5) Reappearance of ditto Mars at quadrature with the Sun	1st Oc. D.	10 37	9 21·6

Book received.—Account of Observations of the Transit of Venus, 1874, made under the authority of the British Government. Edited by Sir G. B. Airy. 1881.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Oct., 1881.
Hemming, Rev. B. F.

To Dec., 1881.
Bridson, J.
Dale, R.
De La Rue, W.
Holland, P.
Lean, W. S.
Liverpool, Lord Bishop of.
Monk, Dr.
Reddiford, W.

To Dec., 1882.
Backhouse, T. W.
Baxendell, J.
Bazley, T. S.
Freeman, G. T.
Hannah, R.
Hollis, W. H.
Jones, Rev. E.
Lamb, Dr.
Lambert, O.
Loddiges, C.
Simms, D.
Walter, Rev. H. S.
Warriner, H.

To Feb., 1882.
Matthews, Rev. W. P. P.

To Dec., 1883.
Lawrence, E.

TO CORRESPONDENTS.

All communications should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, at Lower Clapton, London, E.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 232. APRIL. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1882—83.

Friday, March 10th, 1882.

E. J. Stone, Esq., F.R.S., Director of the Radcliffe Observatory, *President* of the Society, in the Chair.

Secretaries—

J. W. L. Glaisher, Esq., F.R.S., and E. B. Knobel, Esq.

The minutes of the last meeting were read and confirmed.

Mr. Knobel announced that 85 presents had been received since the last meeting. The thanks of the Society were voted to the donors.

The following gentlemen were balloted for and duly elected Fellows of the Society:

Mr. Samuel Jefferson, 17, Virginia Road, Leeds.

Mr. James Leigh, Watford House, King's Norton, near Birmingham.

Professor Pritchard read a paper entitled *Notes on M. Loewy's remarks relative to the wedge extinction method of stellar photometry.* He said: I have replied to the observations made by Mons. Loewy, of the Paris Observatory, as to my method of stellar photometry by means of a dark wedge combined with a variation of the telescopic aperture. Mons. Loewy urges the inequality of the absorptive power of such specimens of neutral tinted glasses as he has hitherto procured, and the inequality of the absorptive

power for different colours. With respect to the wedge used by me, I have examined its action with spectra obtained from the sun and from a gas flame. I have not yet tried it with the electric light, for Oxford has not yet been lit up with electric lights. The absorptive power is very uniform through the spectrum, but it varies a little at the red end; but as this action occurs in the part of the spectrum where the light is very faint, no appreciable inaccuracy will arise therefrom, unless the stars are much more decidedly red than any star visible to the naked eye. Moreover, relative photometry of coloured light does not lie within the reach of any instrument known to me. That disposes of Mons. Loewy's first objection. I might add that it was very unlikely that I should have troubled myself with photometric experiments with neutral tinted glass without finding out whether its absorptive power was or was not equal throughout the spectrum. Secondly, Mons. Loewy finds he cannot rely on the wedge to discriminate differences of light to the extent of the equivalent of seven or eight magnitudes. I reply that in my use of the wedge no two stars differ greatly in light. It is my practice to use the contracted aperture of the telescope in viewing the brighter stars, so that it is neither necessary nor desirable to use very large wedge intervals in any case, nevertheless I have proved the wedge to be reliable for differences extending at least through six magnitudes. Besides this, a skilful use of the wedge extinction and two variations of aperture check each other, and this is a great gain. The second objection, therefore, I hope is met. The paper proceeded to compare in a tabular form the determinations of the magnitudes of 15 stars of the Pleiades group with the results obtained by Prof. Pickering with a photometer entirely different from that employed by us. Professor Pickering partially diminished the light of one star, and then made it equal to another star by means of double refracting prisms, *i.e.*, he reduced the light of the brighter star to the light of the less luminous star by means of two pieces of Iceland spar. In this way Professor Pickering has measured the light of 26 of the Pleiades, and it is very satisfactory to me to find that the results of the comparison show a difference of rather less than $\frac{1}{10}$th of a magnitude. Professor Pritchard exhibited the form of wedge he had used, explaining that Mr. Dawes and Dr. Huggins had used very nearly the same form; the chief difference consisted in the mode of using it.

Mr. Knobel said: I think Professor Pritchard's results are extremely interesting, and I should like to ask him a question or two with regard to the mode of observing, which he has not touched upon. In extinguishing the light of stars by any

apparatus whatever, whether by a wedge or by limiting apertures, one great and essential point is that the extinguishment shall take place rapidly. If you extinguish slowly, the muscles of the eye become strained; but if you extinguish rapidly, the eye has not time to get strained. If you strain the eye, you require a smaller aperture the second time. I would like to ask Professor Pritchard whether by extinguishing stars by this wedge, he does it very rapidly, and then whether, after he has taken the first reading, he takes the second in a denser portion of the wedge than the first. With regard to the accuracy which Professor Pritchard has claimed for his method, if he can get certainty within pretty wide limits, it will be a great advance. Professor Pritchard has mentioned $\frac{1}{10}$th of a magnitude. In the *Monthly Notices*, where we have the results of three observations, the mean deviation is very small indeed, but between the second and third determinations there is a difference of $\frac{3}{10}$ths of a magnitude. Therefore it seems to me, as far as those observations go, there is a higher degree of accuracy claimed than the observations show upon the face of them.

Professor Pritchard, in reply, said*: It is with very great pleasure that I reply to the very natural and apposite question of Mr. Knobel, on a subject which he has himself studied successfully; by such amicable discussions the truth of the fact is elicited. With regard to Mr. Knobel's first question, I reply that the practice in the Oxford Observatory is to push the wedge gradually with the finger as the light of the star diminishes, and when near the point of extinction the rest of the motion is completed by a rack and somewhat rapid pinion. In no case that has been recorded has the light of the star reappeared after apparent extinction, at all events since experience has been acquired in the use of the wedge. Experience is certainly necessary in the use of this instrument, as in almost all other delicate instruments. The earlier observations will probably be worth but little. From experience I have found that the most important feature of all in the construction and use of the wedge lies in the provision of a decided direction of the vision, which can alone, I think, be attained by a pierced diaphragm and flange as large as the pupil of the eye, and extending quite close to the glass itself. Moreover, a pierced diaphragm of about one-tenth of an inch, or smaller, is placed in the focus of the object-glass, and the star examined is brought into the centre of the field, and kept there by the clock. The eye of the observer does not become wearied

* Prof. Pritchard has kindly forwarded us a draft of his reply to Mr. Knobel, which we print in lieu of the shorthand writer's notes.

or excited by the closeness of the attention required, inasmuch as it is necessary to have attention constantly paid to the reading of the scale by means of a small lamp; in this way, I believe, the normal and uniform condition of the eye is maintained.

With reference to Mr. Knobel's second question, relating to the difference of *individual* readings of the wedge, I may state that they are unquestionably more or less considerable, but they are not more discordant than in the case of observing the appulses of the moon's limb or even of a planet's limb, on any single wire of a micrometer. The average deviation from the mean of the readings does not appear to be serious. But, after all, the true test, I think, will be found in the comparison between the Harvard College and the Oxford results. I confess I feel both gratification and increased confidence in finding an amount of both general and individual accordance, which at the outset I hardly ventured to expect. There is now, I think, good hope that before very long we shall have a catalogue of the magnitudes of the stars visible to the eye, on which reliance can be placed within limits by no means existing at present.

Mr. Marth pointed out that in the Seventeenth Volume of the *Monthly Notices* there was a reference by Mr. Carrington to Steinheil's well-known method of employing a moveable diaphragm, similar to that described by M. Loewy, for measuring the magnitudes of stars.

The President: I am afraid there are a great number of old ideas in the world, and all we can say is that if a man re-invents an old thing, and makes a practical use of it, we ought to be indebted to him. (Hear, hear.)

Mr. Christie presented a paper *On observations of occultations of stars by the moon, and the phenomena of Jupiter's satellites, made at the Royal Observatory, Greenwich.* The paper consisted almost entirely of tables.

Mr. Christie also read a paper *On the spectroscopical results for the motions of stars in the line of sight, from observations made at the Royal Observatory in* 1881. He said: This is a continuation of some other papers on the same subject, this being No. 5. The observations have been made with a half-prism spectroscope, with a dispersion of about $18\frac{1}{2}°$ from A to H. Since the beginning of 1881 a convex cylindrical lens has been placed in the viewing telescope, instead of in front of the slit, and a concave (Barlow) lens in the collimator, so that the whole of the object-glass is used. In most of the observations luminous paint has been used to give illumination to the field. Up to the present time the motions of 99 stars have been spectroscopically determined. The results are in many cases still uncertain. In

applying this method we have to deal with stars of very different degrees of brightness. It is only to the very bright stars that we can apply it with advantage. In the case of fainter stars, such as are now included in this list, the observations are necessarily subject to much greater errors of measurement, therefore these results are in some cases rather discordant. The individual measures are given so that anyone can form for himself an idea of the relative value of the observations, and the degree of accuracy that may be expected from them. They are not put forward as giving results with any degree of certainty, but to show what we have done up to the present time.

Mr. Penrose asked whether these results of the moon's occultation and the eclipses of Jupiter's satellites were very different from the predictions given in the *Nautical Almanac?*

Mr. Christie said the predictions of star occultations were only given in the *Almanac* to the nearest minute of time. Occasionally there was a difference in regard to the predictions as to the satellites; but in other cases the predictions agreed with the observations as nearly as might be. It was a question, however, which phase was intended to be given in the *Nautical Almanac.* If it was intended to be the time at which the satellite was last seen at disappearance, or first seen at reappearance, it would depend very much upon the telescope used. More uncertainty was due to that cause probably than to errors in the *Nautical Almanac* predictions of late years.

Mr. Neison: How many occultations of stars have been observed?

Mr. Christie: Rather more than usual, 14.

Mr. Neison: During the years when the nights were remarkably good, the number of occultations observed appear to be very small. In the good years of 1872—3—4, the average was only four or five a year, and now, when the weather has been bad, the number seems to be increasing.

Mr. Christie: It is a fault in the right direction if they are increasing. It has always been the practice at Greenwich to give the greatest attention to observations of occultations, and every occultation is observed when the weather will admit of it, but it frequently happens that an occultation is missed through a passing cloud, or something of that kind.

Mr. Glaisher read a paper by Mr. Burnham *On a new method of bright wire illumination for position micrometers.* Hitherto it has been usual to illuminate the field with faint light, and the wires have been seen as dark objects upon it. The plan pursued by Mr. Burnham is to illuminate the wires. He says the convenience and practical value of this arrangement can only be

appreciated by one who has used the old plan and then tried this; a very feeble light is sufficient to illuminate the wires, so that no object which can be seen is now too faint to be measured.

The President said: This appears to be similar in construction to one Mr. Common has been using. I am sorry to say Mr. Common has left the room, or we might have had an interesting discussion on the differences, if there be any.

Mr. Neison presented a paper by himself and Mr. Campbell *On corrections of the horizontal diameter of the moon from the Greenwich observations made in* 1851-58. The Society will remember there was some discussion between Mr. Stone and ourselves as to the proper correction of the diameter of the moon to be derived from observations of these years. Mr. Stone obtained a result different from ours. In this paper we give full details of our results, so that anyone can verify them as they stand. They give results somewhat different to Mr. Stone, and fully confirming our former result.

Mr. Neison read a paper, *Note on the perturbations of the moon due to the action of Mars.* When at work in the beginning of 1877 on this subject I was led to calculate the value of a number of terms of long period. One of these came out with a co-efficient of several seconds of arc arising from the perturbating effect of the planet Mars, and I then communicated the results in a paper to the Society, pointing out the apparently large value, and remarking that this term closely represents the correction necessary to bring the theory and observation into accord during the long period, 1765-1851. Sir G. Airy had pointed out that after correcting Hansen's tables for the effect of an erroneous term, it left the theory and observations entirely discordant between 1751 and 1851. This term calculated by me exactly represents all the discordances between the theory and observations, and brought them into good agreement. For this reason I communicated it to the Society; remarking that it was only roughly calculated, and that it would be necessary to carry the approximations to far greater extent. Subsequently in another paper I pointed out, owing to my having failed to carry the approximation sufficiently far, the term had come out with a larger value than it ought to have. Lately a paper has been received from M. Constantin Gogau in which he has calculated the value of this term with considerable accuracy by Delaunay's method. His paper forms a very elaborate investigation, and yields the result that this term has an exceedingly small co-efficient, so that it is perfectly insensible. He seems unaware of the fact that I have pointed out that my original value was far too large. Moreover, M. Gogau seems to regard his result as perfectly conclusive; but

this is far from being the case. Like Delaunay, he has only calculated a small portion of this co-efficient; for the effect due to the indirect action of the planet Mars is entirely omitted. The part he has done he has not carried out sufficiently far, for he has neglected terms which seem larger than those which he has calculated. On the other hand, I would take the opportunity of remarking that his calculation is one of the very highest value. It has been done with very great skill and care, and seems to be an important contribution to astronomy. And although it is not carried sufficiently far, we may hope he will undertake the further calculations necessary to complete his work. On the whole I think his value of the co-efficient is rather nearer the truth than the value I originally gave myself.

The President: With regard to the first of Mr. Neison's papers, after looking at it for an instant, I cannot say more than the results he gets out of the semi-diameter agree with mine for the last three years, but differ in the first three years. I will look over the work again, but I think mine is right. With regard to the second paper I do not think Mr. Neison removes the difficulty I pointed out. He has omitted the observations from 1843 to 1851, and that is sufficient to account for the difference. In this investigation it is necessary to divide the observations a little differently so as to get the result little by little; but the quantity he has given is from the observations made by one person. If you apply the diameter of another, you would have something like a selection; but as this is not the case, it will not account for the discrepancy. As I have said before, either Mr. Neison is right and I am wrong, or I am right and Mr. Neison is wrong. At present I must confess I do not think I am wrong. With regard to this large inequality I hardly know that I quite understand the position in which we stand with regard to it. There was certain evidence of the existence of this large inequality brought forward by Mr. Neison, and it appeared there was a probability of its existence. So far as I understand, this young French gentleman has gone through the work, and instead of making the inequality amount to a second it only amounts to $\frac{1}{10}$th. Do I understand Mr. Neison that in his original investigation he took account of something that has not been taken account of by this gentlemen, or did his investigation cover pretty much the same ground, or had he not carried it so far as this gentleman has, but now has carried it to the same extent?

Mr. Neison: I have extended my approximation considerably further than Mr. Gogan even in my first investigation, but I have no doubt my first result was too large, though it is not too great as made out by this new investigator. I think Mr. Gogau has

made it far smaller than it ought to be, and I made it originally far larger. The truth seems to lie between us.

The President: It is certainly a point of great interest that the investigation should be carried a step further, because this long inequality of the time to which our attention is called plays a most important part in the Lunar Theory, and nothing could be more detrimental to suppose the existence of such terms if they have no real existence.

Mr. Knobel read a paper by Mr. S. W. Russell entitled *Measures of double stars made at the Observatory, Sydney, New South Wales.*

The President said: This paper is of great value. It commences a system of re-observing all the double stars observed by Sir John Herschel at the Cape, so as to discover which are physically double and which are only optically double.

Mr. Knobel read a paper by Dr. N. de Konkoly* *On the orbits of meteor streams deduced from observations in Hungary during the years* 1871—80.

Professor Konkoly states that he has a record of about 5,000 meteor paths. The number of meteors coming from probable radiants are about 1,088, and therefore there is one radiant point to 12 meteors as a mean. Then follow calculations of the orbits which he has been able to obtain. He says: "A comparison of meteor orbits with known comets shows that only two accorded, viz., the comet of 1854, 4, and the comet of 1861, 1."

Mr. Neison: This is rather an important paper. If it is correct that the orbits are well derived, and that for over 100 meteor orbits he is unable to identify more than two with comet orbits, it will show that there is less connection between orbits of comets and meteors than is usually supposed. We shall either have to come to the conclusion that comets quickly disappear into meteor streams, and that therefore, in connection with a great number of meteor streams, there are no visible comets, or else it is not essential that all comet orbits should be followed by streams of meteors. Both would be conclusive, but would not accord with our general ideas at present.

Mr. Knobel: Dr. Konkoly says the cause of it may partly be that all the meteor streams have been observed in the descending node.

Mr. Christie: There is also another alternative, namely, that some of these meteor radiants may indicate coming comets. Schiaparelli pointed out the connection between meteors and comets, and found that a connection existed between the meteors and comets recently observed, but if the investigation

* The paper is by M. R. de Kövesligethy, and communicated to the Society by Dr. Konkoly.

had been made a few years earlier, he would have found no such connection, so that we should have come to the same conclusion as Mr. Neison; but it is quite possible that these meteors may be heralds of comets to come, as well as, possibly, indications of comets that have disappeared.

Mr. Ranyard: Does Dr. Konkoly identify only two comets, or does he say two new comets?

Mr. Knobel: His words are, "not so fertile was the comparison of meteor orbits with known comets. I found but two which concurred."

Mr. Ranyard: Unless the earth's orbit passes very close to a comet's orbit, there would be little chance of a meteor moving in the comet's orbit coming into our atmosphere. There are some meteor streams which the earth takes several days to pass through, but if we suppose such streams to be on an average five or ten million miles in diameter, it is only a very few of the comets which are observed which pass within that distance of the earth's orbit, so that the greater number of comets cannot be expected to have observed meteor streams corresponding to them.

Mr. Glaisher read a paper by Dr. Robinson entitled *Notes on the places of three stars in the Armagh Catalogue.*

The President said: This must be the last astronomical work of Dr. Robinson. After devoting a long life to work he seems to have fallen asleep very quietly.

Mr. Neison: The subject I wish now to bring before the meeting is in continuation of one I brought before the Society two years ago, viz., with regard to a supposed change in the moon. Some years ago Dr. Klein drew attention to a peculiar dark formation seen on the moon near Hyginus. It had not been noticed by any previous observer. It excited a good deal of interest at the time, and a number of observers set to work to make observations without any satisfactory result at first. When I read my last paper on this subject I had been trying to make observations of this spot upon the day after the first quarter, but had been unfortunately frustrated by bad weather. Since I read my paper there have been considerable observations made on this subject. Lately Professor Schmidt has published his observations and a considerable number of drawings, and he has arrived at the conclusion that since 1878 this object has been clear and distinct and the second most conspicuous object in the whole region, whereas in every one of his observations previous to that date he was unable to see any trace of it. He concludes that here at least we have an unquestionable case of a real physical change of the moon. I observed the region myself twenty-five times between 1871 and 1876. Several others observed it up to

1877; but for some reason during the beginning of 1877 no one appears to have observed this portion of the moon at all and no known drawing exists. But there is no doubt that if any observer of any experience looks at that region at any time during the thirty-six hours after the sun rises, he now sees a big black object which was never seen before. First of all he sees Hyginus, then this black object, and then the smaller objects. A little alteration of the focus will throw the smaller objects out, but no alteration of the focus will throw out this big black object. When this was first announced it was thought it might have been overlooked previously; but from 1878 to 1881 when any observer looked at this region he saw this object so unmistakably that he could not overlook it. When the sun rises higher, and this black object disappears, all the small craters disappear too. There is little doubt that a real change must have taken place in this part of the moon. It is curious that one or two eminent astronomers have stated that they have been unable to see this object; but no one accustomed to observe the moon has overlooked it. There is some doubt about its character, but whether it be an elevation or a depression, there is no question that it is a black mark which has appeared upon the moon since 1878. Whether it is a volcanic eruption, or a breaking down of the surface, I do not know.

Mr. Bidder: I should like to ask when was the first recorded observation of this object, and whether, since attention has been drawn to it, there has been any reason to suspect any change in its form or magnitude?

Mr. Newall: I think we should like to compare the drawings made some time ago with what is seen now.

Professor Pritchard: It occurs to me that this is very nearly our old friend Linné again. Linné was a moot question of the day. On one occasion I saw Linné as a small crater, and I ran to fetch another person to vouch for my veracity, and when we came back Linné was gone. These appearances of the moon may arise from differences of illumination and of meteorological conditions. I give no opinion on this particular case, but am disposed to hold my judgment in abeyance. We want dates, and hours, and drawings, and everything repeated, so that any person may examine the moon. It should be treated very much as a valuable star is treated. When done over and over again, we may form some conclusion as to whether this is a new form or not. My strong impression is that it has been previously overlooked. If Mr. Neison will give us a list of dates when these particular crater depths are visible, or expected to be, and when they are at their maximum, it will be a great gain, and then we can look out.

Mr. Newall : I have here a drawing of Linné which I made in 1875, and I have never seen it since. A few hours makes all the difference in the world.

Mr. Neison: Linné, as seen by modern observers, was a small crater, so small that you could hardly see it. Since 1865 many have seen Linné. That there is a crater in the centre of the white spot—this is unquestionable; but there has never been seen anything like the great black crater it was uniformly described as before 1860. That is the point, and the only point. If the walls of the black crater have fallen in, so that it looks like a small crater, then the observations before 1865, and after 1865, are reconciled. But here, near Hyginus, is an entirely different thing. Here is an object not visible for a few minutes, or a few hours, but that can be seen systematically from the time the sun rises on this part of the moon till long after, and you cannot look at this portion of the moon without seeing it. It is to be seen on any night when the moon is one day after the first quarter. I have published an account of about 60 of our observations in the *Astronomical Register* and in the *Selenographical Journal*, to which there is an ephemeris stating when it can be seen.

Mr. Bidder observed that Mr. Neison had not answered his questions.

Mr. Ranyard: How is it, if it is such a conspicuous object, there is no photographic evidence that can be brought forward to prove the change?

Mr. Neison: In reply to Mr. Bidder, I may say that no one seems to have observed the moon for at least one year previously to the discovery of this crater, so that it might have appeared any time during then. The conspicuous black spot was discovered by Dr. Klein in 1877. With regard to photographs, there is not one of them that shows this portion of the moon near enough to the terminator. I have drawings which show the object, but no photographs will.

After some conversation as to the appearances of craters in photographs of the moon,

Mr. Christie said: This is an important point, because, so far as I understand this question, there is great difficulty in seeing these craters, except under peculiar conditions of illumination, and if the sun is not quite at the proper angle you cannot see them at all. Therefore, we want to know whether, prior to 1878, there is evidence that this object had been examined under that particular degree of illumination which would bring out the existence of that big black crater.

Mr. Neison: It does not need peculiar circumstances, because we know now that it is visible for 36 hours after sunrise.

The President: Can unskilled observers take it up?

Mr. Neison: Yes. I have a number of drawings from unskilled observers in all parts of the world—in New Zealand, South America, United States, and India, and they differ only as to whether it is a depression or not.

The President: The evidence Mr. Neison brings forward is strong, but at the same time we all have had experience of seeing things which it seems incredible we should have previously overlooked. This is constantly our experience with nebulæ.

Mr. Green: I have distinctly seen the crater on three occasions with the same illumination, just at the edge of the terminator. It is a much easier object to see than the small craters around it, and therefore, I think, there is strong proof that anyone who had made a drawing of that place previously, and had put in the small craters, could not possibly have omitted this large dark spot if it was as distinct as it is now.

Mr. Christie: What I want to know is whether the small craters would be seen under conditions of illumination that would have made this black spot visible?

Mr. Neison: I have about 150 drawings of these small craters, all made previously to 1877, with the date of the observations, so that you know how they were seen. I have only referred to the drawings that show these craters at the time when the black spot, now so conspicuous, ought to have been seen on every one of them, but there is not a single trace of the black spot to be seen.

The following papers were also announced:

H. C. Russell: *The transit of Mercury,* 1881, *Nov.* 7, *observed in New South Wales.*

D. Gill: *Note on the north polar distance of the star Lacaille* 4342.

H. C. Rockwell: *Observations of the transit of Mercury,* 1881, *Nov.* 7, *made at Honolulu, Sandwich Islands.*

J. Tebbutt: *Observations of Comet III.* 1881, *made at Windsor, New South Wales.*

J. R. Capron: *Observations of the lunar eclipse,* 1881, *Dec.* 5.

C. Piazzi Smyth: *Revision of* 21 *places in the red half of the solar spectrum with a Rutherfurd diffraction grating, at Madeira, during the summer of* 1881.

E. J. Stone: *Observations of occultations of stars by the moon, and of phenomena of Jupiter's satellites, made at the Radcliffe Observatory, Oxford.*

Mons. Loewy: *Réponse à la communication faite à la Société Royale Astronomique par M. Marth, au sujet de mon appareil pour la détermination des flexures.*

REVIEWS.

Spectroscopic Observations made at the Royal Observatory, Greenwich, 1880. pp. 84.

Amongst these copious and valuable observations there is a table of mean results for motions of stars in the line of sight, from spectroscopic observations at Greenwich from 1875 to 1880. The concluded motions are given in miles per second, and rough estimates of probable errors are sometimes appended. From this table, which includes 90 stars, we extract the following (the velocity of light has been taken as 186,660 miles per second, and the distance of the sun as 92,250,000 miles). Stars approaching: α Andromedæ, 35 ± 3·5; γ Pegasi, 37; γ Cassiopeiæ, 26; β Arietis, 13; α Piscium, 35; α Arietis, 15; β Persei, 30; γ Orionis, 0 ± 2·0; β Tauri, 15; ϵ Orionis, 15 ± 6·4; κ Orionis, 1; Pollux, 27 ± 2·7; ϵ Leonis, 13; γ^1 Leonis, 32 ± 4·3; α Ursæ Majoris, 21; δ Leonis, 28; ϵ Virginis, 28; η Ursæ Majoris, 12; Arcturus, 32 ± 2·0; ϵ^2 Boötis, 4 ± 3·1; ζ Draconis, 24; α Herculis, 32; γ Draconis, 17 ± 2·8; α Lyræ, 34 ± 1·9; ζ Aquilæ, 21 ± 12·8; β Cygni, 18; γ Aquilæ, 28; δ Cygni, 18 ± 3·3; α Aquilæ, 13 ± 7·6; γ Cygni, 16 ± 2·6; α Cygni, 41 ± 3·6; ϵ Pegasi, 17 ± 1·8; η Pegasi, 17; α Pegasi, 33 ± 4·2. Stars receding: β Andromedæ, 12; α Persei, 23; Aldebaran, 22 ± 2·3; Capella, 29 ± 3·6, Rigel, 19 ± 1·7; δ Orionis, 5 ± 5·1; ζ Orionis, 9; α Orionis, 19 ± 1·9; β Aurigæ, 3; γ Geminorum, 10; Sirius, 19 ± 2·0; Castor, 27 ± 3·4; Procyon, 25 ± 2·8; α Hydræ, 38; Regulus 26 ± 2·2; β Ursæ Majoris, 24 ± 4·0; β Leonis, 25; γ Ursæ Majoris, 15 ± 2·3; δ Ursæ Majoris, 11; ϵ Ursæ Majoris, 16 ± 2·8; Spica, 6 ± 3·2; ζ Ursæ Majoris, 22; β Ursæ Minoris, 29; β Libræ, 16; α Coronæ, 41 ± 4·1; ϵ Serpentis, 33; ζ Herculis, 23; β Draconis, 19; α Ophiuchi, 8 ± 4·7; γ Lyræ, 9; α Delphini, 23; ϵ Cygni, 16; β Pegasi, 20.

Weights from 1 upwards are appended, the highest being Arcturus, 110; α Lyræ, 126; Sirius, 81; Pollux, 74: Procyon, 65; α Orionis, 54; Capella, 53; α Cygni, 51; Regulus, 48; Rigel, 40½; α Ophiuchi, 38; γ Cygni, 37; Spica and ϵ^2 Boötis, 36; α Coronæ, 35; Castor, β Ursæ Majoris, and α Pegasi, 34. Amongst those we have selected the lowest weights are β Persei and α Delphini, 3.

Account of Observations of the Total Solar Eclipse of the 29th July, 1878, *made at Cherry Creek Camp, near Denver, Colorado.* By A. Cowper Ranyard, Esq., M.A., F.R.A.S. With a plate. London: Published by the Society at their apartments, Burlington House. 1881.

Professor C. A. Young kindly invited Mr. Ranyard to join his eclipse party, and with all its members rendered every needful assistance. No trace of the moon's limb could be detected outside the sun's disc during the eclipse. Prof. Young observed with one of Mr. Rutherfurd's gratings of 17,300 lines to the inch, but could not detect, nor could Mr. Ranyard, any thickening of lines or alteration of the solar spectrum, indicating the existence of a lunar atmosphere. In a general survey of the corona all round the moon there were no tree-like or branching structures seen, as in the 1871 corona photographs, nor could any synclinal groups of structure be traced. Two of the dry plates which had been exposed for one second and three seconds, gave images of the corona extending respectively to a height of more than 4′ and of 6′ or 7′ above the moon's limb. From these a lithographic drawing has been made. Mr. Ranyard remarks, "The sun's disc was remarkably free from spots for the few months preceding and following the eclipse. . . . It seems evident from the photographs and drawings made during the eclipse, that the

bright structures of the corona extended to a much greater distance from the sun's limb in the equatorial than in the polar regions, and that the difference between the extent of the corona in the equatorial and polar regions was greater on this occasion, both as observed with the naked eye and with the telescope, and as shown upon the photographs, than in the coronas observed during the eclipses of 1870 and 1871. A comparison of the drawings made during other total eclipses, which are given in the Eclipse Volume, tends to show that a greater development of the corona in the equatorial than in the polar regions is one of the characteristics of coronas which have been observed during periods when there were few sun spots."

"It seems probable that the radial polarisation of the corona extended with less diminution in intensity down to the moon's limb than in the coronas of 1860 and 1870, and that there was less difference in the intensity of the polarisation of light dispersed by the matter filling the rifts and by the matter of the brighter parts of the corona than in the coronas of 1870 and 1871. "The monochromatic images of the corona appear to have been (relatively to the whole light of the corona) fainter on this occasion than in the corona of 1871. The bright structures of the corona seem to have been less strikingly curved than in the coronas of 1860, 1870, and 1871, and no great tree-like branching structures, such as are to be seen in the 1871 photographs, appear to have been observed on this occasion." A drawing of the corona by Dr. Charles Denison, of Denver, accompanies this account, which shows a synclinal grouping of the coronal structures, which does not appear in the photographs. In the drawing by Mr. Penrose (*Monthly Notices*), who accompanied Mr. Ranyard to Denver, a similar grouping of structures appears, as also in the drawings by American observers.

Notwithstanding various mishaps and consequent disappointment with the photographs, Mr. Ranyard's eclipse expedition was not fruitless, and he has given a full and interesting discussion of what he was enabled to observe.

Victoria. Sixteenth Report of the Board of Visitors to the Observatory, together with the Annual Report of the Government Astronomer. Presented to both Houses of Parliament by His Excellency's command. By authority. John Ferres, Government Printer, Melbourne.

Twenty-two nebulæ of Sir John Herschel's catalogue, with a new one not previously recorded, were observed and sketched, the position of the new one being 4′ 30″ south of H. 3705, and preceding it by 67 seconds of time. The majority of the nebulæ observed agree well with Herschel's description, with the exception of Nos. 4502, 4510, and 5012, which do not agree with Herschel's measures; 3430 is much more suddenly condensed in the centre, while 3734 is much fainter than Herschel describes. Sixty-four photographs of the moon in different phases were obtained. The nebula surrounding η Argûs was on three occasions carefully compared with the drawings of 1875, but no decided change could be detected. 175 photographs of the sun have been obtained. The mirrors of the great telescope still retain a good working polish, although there is an appreciable diminution of reflective power from a faint and general tarnish on the large mirror. Magnetic and meteorological work, time signals and distribution, inter-colonial meteorology, and special work for the public, testing and regulating instruments, chronometers, &c., have occupied Mr. Ellery and his assistants, Messrs. White (chief), Moerlin, Turner, and Gilbert, in addition to astronomical work proper. Owing to

the preparation of the second general catalogue, the transit-circle since January has been almost exclusively used for observations for clock corrections. To supply the felt want of clerical and computing assistance, the Board of Visitors recommend that £100 a year be placed at the disposal of Mr. Ellery. They say in their report, "It is due to the astronomer and his assistants to add that we found everything in perfect order. A large amount of important work is constantly going on at the observatory, and no opportunity is lost of extending its usefulness to scientific research, and to the practical needs of the community." The great influx of visitors to Melbourne during the International Exhibition, led to incessant requests for opportunities to see some of the heavenly bodies through the large reflector. It was well to comply as far as possible with these requests, though a larger number (82) of nights than usual had to be given up for this purpose. Unfavourable weather or bright moonlight interfered on 125 nights. There seems a probability that the erection of a new transit-circle will not be delayed much longer. The report embraces the year commencing 1st July, 1880, and ending 30th June, 1881.

Sur la Distribution de l'Energie dans le Spectre solaire normal. Par M. S.-P. Langley. (Presented to the Academy of Sciences, Paris, March and July, 1881.)

Professor Langley believes that the total amount of heat sent by the sun to the earth is far greater than what the most accredited and able astronomers have thought. He also says, "If all the solar radiations reached us, we should have a sensation of blue rather than of white. The atmospheric medium which we are accustomed to regard as transparent, performs the part of so strongly coloured a medium, that the residue of the transmitted ray no more resembles the real colour of the photosphere than the electric light seen through a reddish glass resembles that of the incandescent carbons."

As the result of 15,000 measures with his bolometer, Prof. Langley has drawn the curves which represent—1. The normal spectrum after undergoing the zenithal absorption of our atmosphere. 2. The normal spectrum before the absorption by the terrestrial atmosphere. The comparison is very striking. The Professor (Alleghany Observatory) is continuing these interesting researches.

Meteorological Observations made at the Adelaide Observatory during the year 1879, under the direction of Charles Todd, C.M.G., F.R.A.S., Observer, Postmaster-General, and Superintendent of Telegraphs. Published by authority of the Government of South Australia. Adelaide: E. Spiller, Government Printer. 1881. pp. 250.

We cannot conceive of a more exhaustive series of meteorological observations than are contained in the annual volume published at Adelaide. The present one has a large photograph of the 8-inch equatorial by Cooke, under its dome; another of the thermometer house; a rainfall map of S. Australia for 1879; a map of approximate annual rainfall, and monthly meteorological curves as usual. Appendix I. has a number of abstracts and results. Appendix II. observations of eclipses, occultations, and transit of Jupiter's satellites, and notes on the physical appearance of Jupiter. On October 31, 1879, after the occultation of the 3rd satellite, Mr. Todd and Mr. Ringwood felt confident of seeing flashes of it well or wholly within the limb. This was several minutes before final disappearance. Appendix III. gives abstract of meteorological results at ten out-stations.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

NOTES ON PLATO.

Sir,—The observations of Plato made here during the last few months have resulted in the detection or verification of several additional features on the floor of this interesting formation.

In a sketch by Mr. W. F. Denning, dated the 12th August, 1881 (published in the *English Mechanic*, Vol. XXXIII., p. 570), a spot is shown near the north-west border at the intersection of the streak a, o with "Webb's Elbow." This spot, which has been registered as 39, has been seen on many occasions since, and is, indeed, as bright as 13, which is one of the more conspicuous spots. The discovery of this object accounts for a circumstance which I have frequently noticed, namely, the placing of spot 13 sometimes on streak o, and sometimes further to the south. The new spot, 39, though so bright, yet is somewhat difficult to see, on account of the great brightness of "Webb's Elbow," on which it is situate.

In the above-mentioned sketch two other spots are shown, one being on streak γ near the wall, and the other on streak η, also close to the wall. These also have been since seen on several occasions, and have been registered, the one on streak γ as No. 40, and the one on streak η as No. 41.

On March 16th, 1881, I saw a spot south a little west of 14, close under the border, which would seem to have been also seen by Mr. Denning on Sept. 9, 1881, and which has been noted once or twice recently. It has been registered as No. 42.

On March 2, 1882, 24 spots were seen on the floor with my $3\frac{1}{4}$-in. Calver reflector, and two streaks were observed which appear to be new. One connected γ with η, and seems to be too far south to be s; the spot 7 is situate on it. The other streak ran from spot 16 to the north wall. I shall be glad to hear of any observations of the above objects.

West Brighton:
March 18th, 1882.

Yours faithfully,
A. STANLEY WILLIAMS.

VARIABLE STARS.

Permit me to correct two misprints which occur in my letter in present issue. "*Nine* years ago" should be "*some*," &c., and "*Gurnall*," "*Turnall*."

Has anyone suspected variability in regard to α Andromedæ? B.A.C., 1: J. Herschel, 2·54; Argelander 2; Heis, 2; Turnall, 2·0; Flammarion, 2·0; Baxendell, 2·36. J. Herschel makes it 0·04 inferior to γ. I have repeatedly observed it to be superior to that star, and on 5th Jan. (at 7·30 p.m.) I found it about one-tenth brighter than α Persei. The latter star is rated by Sir J. Herschel at 2·07. The differences are more curious as α Andromedæ is white.

Mr. Gore might have added to his list of estimates of η Cygni the following: B.A.C., 5; Turnall, 5·0; Turnall, 5 V.

Can he and Mr. Baxendell supply any information concerning the stars in the Plough?

Glasgow: Feb. 8. I am yours faithfully,
S. MAITLAND BAIRD GEMMILL.

CANALS IN MARS.

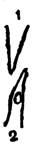
Sir,—Through the kindness of Sig. Schiaparelli, the celebrated Director of the Observatory at Milan, I am enabled to communicate to your readers the surprising fact that the so-called *canals* in Mars, of which he gave a renewed and improved delineation as again seen in 1879-80, were found by him during the recent season *doubled* by similar and parallel dark bands at varying distances. As many as 20 of these strange duplications were observed with much certainty. They follow in general the direction of "great circles," and give to the equatorial region of the planet the aspect of a gigantic network; a discovery which, as he remarks, will go far to change current opinions as to the physical constitution of the planet, and in which he is disposed to find indications of change of seasons. Other interesting variations were noted, especially in the form of the *Syrtis Magna* (Kaiser Sea) which he thinks show less fixity in the dark patches than has usually been ascribed to them. This most important communication was read at a meeting of the "Accademia dei Lincei," on March 5, and is to be followed by a more extended and detailed memoir, on which the author is employed at the present time, and to which we shall all look forward with especial interest.

March 28, 1882. T. W. WEBB.

LUNAR WORK FOR APRIL, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Mare Crisium. Near the extremity of the *Promontorium Lavinium*, which is the southern one of the two forming the "Pass" east of *Picard*, is a small crater shown in Neison's map. But there is also one on or near the extremity of the *Promontorium Olivium* (the northern promontory) which is not shown by Neison. For some reason or other this crater is by no means so frequently visible as that on the *Prom. Lavinium*, and I should be glad to obtain notes of the dates at which it has been seen, and description of its precise position.



The promontories referred to do not end quite so abruptly as Neison has drawn them in his map, but slope down rapidly to the level of the Mare, their actual extremities over-lapping, to some extent, as shown in the margin, though the drawing is probably somewhat exaggerated, and shows the crater much too far from the end of the promontory. In a sketch I made on, 1879, Dec. 30, 11h. 30m. to 12h., the two craters are shown almost joining, but the one on *P. Lavinium* is a little east of the end of the promontory. I thought at the time that the one on *P. Olivium* was rather the smaller of the two; but though the definition was very good, the wind was high, and the telescope was so unsteady as to make the observation less satisfactory than I should have wished.

Peirce A. Among the drawings of Tobias Mayer, photographs of which are in the library of the R.A.S., is one (No. 14) of the *Mare Crisium*. It is dated 1749, Nov. 25, 12h. 45m., the evening terminator crossing the western portion of the *Mare*. In this drawing *Picard* and *Peirce* are shown very plainly, but *Peirce A* is not shown, a broad bright streak (from *Proclus*) apparently covering it. I must add, however, that much weight can scarcely be given to these drawings, as in another (No. 15) of the same collection, dated 1749, Nov. 11, 30h., *Fracastorius* is plainly delineated as a *complete circle*.

Cleomedes. On April 21, the illumination of the moon will be very similar to what it was on Dec. 24, 1881, when Mr. A. S. Williams could not discern *Cleomedes A*. This will be a good opportunity for verifying his observation.

Mare Serenitatis. On, 1868, July 25, 9h., Mr. Birt was observing this portion of the moon, the terminator being a little to the east of *Bessel*. He noted that the shadow cast by Bessel was horned, "very curious with two needle points N. and S., indicating that although the ring is complete, the eastern portion is depressed below the N. and S. portions."

The same appearance was observed by Mr. Newall, some time early in 1877. He said, "Bessel casts a curious shadow shortly after sunrise; there are two horns, one on each side of the shadow, and these appear to be cast by two peaks on the crater ring. I saw them again at sunset, when Bessel was just on the terminator, and the shadow on the ring was cast the other way."

Neison says that "the wall rises on the west 1,592 feet above the *Mare*," and adds that "Schröter and Lohrmann consider that a peak exists on both the south and north wall, and, according to the former, about 100 feet above the crest of the wall." It is somewhat singular that Neison should have measured the shadow without noticing the horns at the end of it, which, according to Birt's drawing, are about one-third the length of the shadow, and according to Newall's about one-fourth.

Drawings should be made of this shadow, special care being taken to give its form and length correctly.

It may be added that, according to Neison, Webb has twice seen apparently a central peak in Bessel, though none was seen by Mädler.

St. Mary's, Bayswater:
March 18, 1882.

LONGITUDE OF THE MOON'S TERMINATOR at MIDNIGHT.

N.B. — Means East. + West. M., Morning Terminator.
E., Evening Terminator.

1882.		° ′			° ′	
April	1	−72 18	M.	April 16	−75 13	E.
	2	84 29		17	87 24	
	3	+83 19	E.	18	+80 22	M.
	4	71 7		19	68 11	
	5	58 56		20	55 58	
	6	46 44		21	43 47	
	7	34 33		22	31 34	
	8	22 21		23	19 22	
	9	10 10		24	7 10	
	10	− 2 2	E.	25	− 5 2	M.
	11	14 13		26	17 15	
	12	26 25		27	29 27	
	13	38 38		28	41 40	
	14	50 49		29	53 51	
	15	63 1		30	66 4	

Moon nearest the earth ... April 15, 5h.
„ farthest from the earth „ 27, 3h.

DUN ECHT CIRCULAR, No. 45.

Dr. J. Palisa kindly communicates from Vienna, by a *Science Observer* Code telegram, an exact position of a new comet, which was probably discovered in America, as it is called "American" in the message.

The telegraphed position is:

Greenwich M. T.	App. α.	App. δ.
1882, March 21·4819	17h. 57m. 38·6s.	+34° 22′ 4″.

A circular received from Dr. Oppenheim, Berlin, gives the first American observation as:

Greenwich M. T.	App. α.	App δ.
1882, March 19·6894	17h. 54m. 38·1s.	+33° 25′ 5″.

[The Declination ought perhaps to be +33° 24′ 5″.]

The comet is described as having a tolerably well defined round nucleus, less than 1′ in diameter, as bright as a star of the eighth magnitude, with a tail less than half a degree in length.

Here the sky is completely overcast.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, March 23.

DUN ECHT CIRCULAR, No. 46.

A *Science Observer* telegram of nineteen words, received from Boston, U.S., states that the new comet was discovered by — Wells, probably on March 18. The same telegram contains Elements and an Ephemeris computed by Mr. S. C. Chandler, jun., of Harvard College, from observations on March 18, 19, and 22.

Elements.

$$\begin{aligned} T &= 1882,\ \text{June } 1{\cdot}42,\ \text{Greenwich M.T.} \\ \pi\text{-}\Omega &= 222^\circ\ 19' \\ \Omega &= 200\ \ 11 \\ i &= 70\ \ 51 \\ \log. q &= 7{\cdot}7782 \end{aligned} \left.\vphantom{\begin{aligned}a\\b\\c\end{aligned}}\right\} \text{Mean Equinox } 1882{\cdot}0.$$

Ephemeris for Greenwich Midnight.

1882	α h. m. s.	δ ° ′	Brightness.
Mar. 23	18 1 32	+35 39	1·03
27	18 8 52	38 5	
31	18 17 4	40 50	
April 4	18 26 16	+43 51	2·49

The comet was observed by Mr. Lohse as follows:

Dun Echt M.T.	App. α	App. δ
1882, Mar. 23, 9h. 33m. 47s.	18h. 0m. 56·00s.	+35° 25′ 43″·7

The comet is moderately bright; it has a straight tail about 6′ long, almost exactly *preceding*.

Lord Crawford's Observatory, Dun Echt: 1882, March 25.

RALPH COPELAND.

DUN ECHT CIRCULAR, No. 47.

Another code telegram has arrived from the *Science Observer*, Boston, U.S., containing a second set of elements and an ephemeris of comet Wells, computed by Professors Pickering and Boss.

Elements.

$$\begin{aligned} T &= 1882,\ \text{June } 15{\cdot}76.\ \text{Greenwich M.T.} \\ \pi\text{-}\Omega &= 202^\circ\ 57' \\ \Omega &= 206\ \ 40 \\ i &= 74\ \ 47 \\ \log. q &= 9{\cdot}0257 \end{aligned} \left.\vphantom{\begin{aligned}a\\b\\c\end{aligned}}\right\} \text{Mean Equinox, } 1882{\cdot}0$$

Ephemeris for Greenwich Midnight.

1882	α h. m. s.	δ ° ′	Brightness.
Mar. 25	18 5 0	+36 47	1·20
29	18 12 20	39 16	
April 2	18 20 24	41 58	
6	18 29 16	+44 53	1·50

Lord Crawford's Observatory, Dun Echt: 1882, March 25.

RALPH COPELAND.

DUN ECHT CIRCULAR, No. 48.

Dr. Holetschek has kindly forwarded from the Imperial Observatory, Vienna, a further set of elements and an ephemeris of comet Wells. These were transmitted, as usual, by the self-checking *Science Observer* code devised by Messrs. Chandler and Ritchie.

The computations are based on observations made on March 19, 21, and 23.

Elements.

$$T = 1882, \text{ June } 8{\cdot}51, \text{ Greenwich M.T.}$$
$$\left.\begin{array}{rl} \pi\text{-}\Omega = & 211^\circ\ 56' \\ \Omega = & 203\ \ 34 \\ i = & 72\ \ 51 \end{array}\right\} \quad \text{Mean Equinox } 1882{\cdot}0$$
$$\log q = 8{\cdot}6484$$

Ephemeris for Berlin Midnight.

1882.	α	δ	Brightness.
	h. m. s.	° ′	
Mar. 25	18 4 36	+36 37	1·01
29	18 12 4	39 7	
April 2	18 20 16	41 51	
6	18 29 24	+44 50	1·78

Lord Crawford's Observatory, Dun Echt: 1882, March 27.

RALPH COPELAND.

THE PLANETS FOR APRIL.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	23 18 26	S. 7 2½	6″·2	22 35·8
	9th	0 3 37	S. 2 18½	5″·6	22 49·4
	17th	0 54 5	S. 3 33½	5″·2	23 8·2
	25th	1 51 10	S. 10 15	5″·0	23 33·7
Venus ...	1st	1 21 1	N. 7 31½	9″·8	0 41·9
	9th	1 58 4	N. 11 20½	10″·0	0 47·4
	17th	2 35 59	N. 14 52½	10″·0	0 53·8
	25th	2 35 59	N. 15 42	10″·0	1 1·2
Mars ...	1st	6 53 50	N. 25 12½	8″·4	6 13·8
	9th	7 9 26	N. 24 42	8″·0	7 58·0
	17th	7 25 46	N. 24 5	7″·6	5 42·8
	25th	7 42 38	N. 23 20	7″·2	5 28·2
Uranus ...	3rd	11 7 26	N. 6 30½	3″·8	10 18·9
	19th	11 5 32	N. 6 42	3″·8	9 14·1

Mercury rises about half an hour before the sun at the beginning of the month, the interval decreasing.

Venus sets about fifty minutes after the sun on the 1st, the interval increasing.

Mars sets two hours and three quarters after midnight at the beginning of the month, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR APRIL, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
						β Leonis
Sat	1	11 31 11 45 17	Occultation of *e* Leonis (5) Reappearance of ditto Mars at quadrature with the Sun	1st Oc. D.	10 37	— 11 2·3
Sun	2		Sidereal Time at Mean Noon 0h. 42m. 54·94s.	1st Tr. I. 1st Sh. I. 1st Tr. E.	7 46 8 41 9 59	10 58·4
Mon	3	5 46	○ Full Moon Sun's Meridian Passage 3m. 17·85s. after Mean Noon	3rd Tr. I. 1st Ec. R. 3rd Tr. E.	7 45 8 12 18 9 58	10 54·4
Tues	4			2nd Tr. I.	10 25	10 50·5
Wed	5					10 46·6
Thur	6			2nd Ec. R.	8 57 40	10 42·6
Fri	7					10 38·7
Sat	8	17 40	Near approach of B.A.C. 5954 (6)			10 34·7
Sun	9			1st Tr. I.	9 47	10 30·8
Mon	10	18 29	☾ Moon's Last Quarter	1st Oc. D. 1st Ec. R.	7 8 10 7 39	10 26·9
Tues	11			1st Sh. E.	7 18	10 22·9
Wed	12					10 19·0
Thur	13			2nd Oc. D.	7 26	10 15·1
Fri	14		Saturn's Ring: Major axis=37″·04 Minor axis=13″·11	3rd Ec. R.	7 21 36	10 11·1
Sat	15		Illuminated portion of disc of Venus=0″·974 Illuminated portion of disc of Mars=0·901			10 7·2
Sun	16	10	Conjunction of Moon and Mercury 6° 28′ S. Sidereal Time at Mean Noon 1h. 38m. 6·68s.			10 3·3

DATE.		Principal Occurrences. h. m.		Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. β Leonis
Mon	17	9 38	● New Moon Sun's Meridian Passage 0m. 29·65s. before Mean Noon	1st Oc. D.	9 10	9 59·3
Tues	18	12 14	Conjunction of Moon and Venus 1° 52′ S. Conjunction of Moon and Saturn 3° 38′ S.	1st Sh. I. 1st Tr. E. 1st Sh. E.	7 0 8 32 9 13	9 55·4
Wed	19	7 16	Conjunction of Saturn and Venus 1° 53′ N. Conjunction of Moon and Jupiter 0° 40′ S.			9 51·5
Thur	20	23	Conjunction of Neptune and Venus 1° 34′ N.			9 47·5
Fri	21	9 14 10 1	Occultation of B.A.C. 1733 (6½) Reappearance of ditto	3rd Oc. R. 3rd Ec. D.	9 0 9 35 9	9 43·6
Sat	22			2nd Tr. E. 2nd Sh. E.	8 10 9 25	9 39·7
Sun	23	21	Conjunction of Moon and Mars 6° 17′ N.			9 35·7
Mon	24	18 55	☽ Moon's First Quarter.			9 31·8
Tues	25	7 26 8 39	Occultation of 60 Cancri (6) Reappearance of ditto	1st Tr. I. 1st Sh. I.	8 20 8 55	9 27·9
Wed	26			1st Ec. R.	8 26 51	9 23·9
Thur	27					9 20·0
Fri	28					9 16·1
Sat	29			2nd Tr. I.	8 19	9 12·1
Sun	30	13 35 14 24	Occultation of B.A.C. 4312 (6) Reappearance of ditto			9 8·2
MAY Mon	1	19	Superior conjunction of Mercury and Sun	1st Sh. I. 1st Tr. I.	15 6 15 39	9 4·3

Books received.—Comets. By Wm. Huggins. Jan. 20, 1882.—Ciel et Terre. Bruxelles: Xavier Havermans, Gallerie du Commerce.—Micrometrical Measurements of Double Stars, 1879-80. University of Cincinnati. 1882.—L'Astronomie. No. 1. Par Camille Flammarion. Paris: Gauthier-Villars. 1882.—The Sidereal Messenger. Carleton College, Minnesota.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Dec., 1881.	To June, 1882.	To Dec., 1882.
Calver, G.	Gray, T. P.	Aldam, W.
Dallmeyer, J. H.	Huggins, W.	Elliott, R.
Homer, Rev. J.		Garnett, W.
		Johnson, R. C.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, Chief Office,, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 233. MAY. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1882—83.

April 14th, 1882.

E. J. Stone, Esq., *President* in the Chair.

Secretaries—J. W. L. Glaisher, Esq., and E. B. Knobel, Esq.

The minutes of the previous meeting were read and confirmed.

Mr. Knobel announced the receipt of 61 presents since the last meeting of the Society, among which he specially called attention to a number of the *Bulletin des Sciences Mathématiques et Astronomiques*, containing a curious catalogue of southern stars made by a Dutchman, Frederic Houtman, at Sumatra, in the year 1600, for the benefit of southern navigators. It was originally published at Amsterdam, but had become extremely rare, and had now been reprinted in the *Bulletin des Sciences.*

Robert T. Pett, Esq., Royal Observatory, Cape of Good Hope,

was balloted for and duly elected a Fellow of the Society.

Mr. Glaisher read two papers from Professor Asaph Hall *On the conjunctions of the interior satellites of Saturn*, being observations from Sept. 29, 1881, to Jan. 27, 1882, and *Observations of the companion of Sirius*, made at the United States Naval Observatory at Washington, from Feb. 27, 1882, to March 31, 1882.

Mr. Glaisher read a paper by Professor Holden *On the inclination of the ring of Saturn to its orbit, deduced from the Washington observations.* The observations were made by Professors Holden and Asaph Hall during 1877-8-9 with the 26-inch Clark refractor. The results of Prof. Holden's observations agreed with those of Bessel, while Prof. Hall's observations appeared to indicate a slight diminution in the inclination since 1818.

The President: These results appear to be very interesting in many respects. It appears that there has been little change since Bessel's time in the inclination of the ring to the orbit.

Mr. Glaisher read a paper by Mr. R. L. J. Ellery, being a list of errata in the first Melbourne General Catalogue of stars. Mr. Ellery mentioned that the discrepancy pointed out by Mr. Downing in his paper on the north polar distances of the Cape Catalogue, 1880, between the N.P.D. of the star Lacaille 4342, as given in the Melbourne and Cape Catalogues, was explained by a typographical error in the Melbourne Catalogue where a figure 3 was printed instead of 8. Observations extending over 15 years showed no appreciable change of the polar distance of the star referred to.

Mr. Downing: It is somewhat remarkable that a comparison of Lacaille's place of the star No. 4342 in his catalogue, with the place in Mr. Stone's catalogue gives nearly the same proper motion as the comparison of the latter with the erroneous place in the Melbourne Catalogue gives. It would appear from this, as Mr. Stone has, I think, pointed out, that Lacaille's places, as at present reduced, are useless for the determination of proper motion, and any value deduced from them cannot be accepted as final.

The President: The remark that Mr. Downing has made is perfectly true, but the observations may be employed for differential comparisons, and probably might be made useful if we used the modern observations as zero points. The mere discordances of Lacaille's places cannot be trusted with regard to proper motions, but it may be worth while to look into them, for some are real. In the errata which Mr. Ellery has sent the errors are not very numerous nor important, considering the enormous amount of work done in the volume. It is, however, desirable that when errors are discovered in an important catalogue they should be put on record in our *Notices.*

Mr. Glaisher read a paper by T. E. Espin *On the variable star β Ursæ Minoris.*

The President: The variability is supposed to be about $\frac{6}{10}$ths of a magnitude.

Mr. Knobel: I have made one or two comparisons of β Ursæ

Minoris with Polaris, and have found only $\frac{1}{10}$th difference. The range of magnitude given in the paper is $\frac{2}{10}$ths, but I presume Mr. Espin takes Polaris as a second magnitude star.

Mr. Knobel read a paper by Professor Newcomb, entitled *Remarks on the instructions for observing the transit of Venus, formulated at the Paris International Conference in October*, 1881.

The writer said: I have some hesitation in suggesting improvements in instructions which have been drawn up by the eminent astronomers who took part in the Conference. The subject is, however, of great importance to Americans, as their observers will probably be as numerous as those of all the other countries who will send out expeditions to observe the transit. In regard to the first three articles of the Instructions, I am unable to suggest any amendment, except that the use of the silvered objective might cut off too much light in the case of the sun's rays being observed by haze. In actual observations everything depends on the observers seeing the gradual approach of the sharp cusps around Venus, and estimating the moment at which the thread of light became visible. The greater the brilliancy the more readily it would seem must such phases as this be discriminated. The brilliancy of the solar disc should therefore be made as great as the eye can bear with comfort. In article IV. of the Instructions the observer is instructed to note at ingress the moment when there is seen for the last time a decided and persistent discontinuity in the illumination of the apparent limb of the sun. I do not understand the precise meaning of these words. The moment of true internal contact is that at which the sharp points of the cusps begin to meet round the dark body of the planet; the definition of the limb, however, never being perfect, it is impossible to fix this moment with perfect accuracy. The ends of the cusps are rounded, broken up, and diffused, so that internal contact does not show itself by the completion of the line of the sun's limb, but by the gradual combination of the ill-defined lines of light which form the cusps—a slow and gradual process, occupying from a few seconds to a minute. This renders it impossible to define the exact moment when there is a decided discontinuity or continuity in the limb of the sun. The Instructions endeavour to surmount this difficulty by describing the various phenomena to be expected, but the definitions are not sufficiently precise. With regard to the "black drop," the only phenomena seen are those of a greater or less degree of illumination. The "black drop" can only mean that the cusps appear rounded instead of sharp. I will now take the Instructions in order. I. Accurately defines the phenomena of geometrical contact. II. "S'il se produit une goutte

noire ou ligament, bien net et aussi obscur que le corps même de la planète, les instants définis précédemment sont, à l'entrée celui de la rupture définitive, à la sortie celui de la première apparition du ligament." This definition may lead to the time of ingress being noted too late and that of egress too early. The Instructions would seem to imply that at ingress the first appearance of darkening is to be noted, and at egress the moment when it is about to disappear, which would probably lead to mistakes, like that made by Mr. Tebbutt in his observation of the transit of 1874. He appears to have failed to observe either contact by waiting at ingress till the ligament had almost disappeared, and at egress by endeavouring to catch its first formation. III. "Si, les bords restant sans déformation, il se produit un obscurcissement du filet lumineux, sans que l'ombre devienne jamais aussi noire que le corps de la planète, l'observateur notera l'instant du contact géométrique. Il devra noter de plus l'instant de la formation ou de la disparition de l'ombre." This instruction could not be carried out, as there is no precise moment when the shade commences. IV. "Si l'ombre interposée est d'abord, ou devient aussi noire que le corps de la planète, l'instant défini précédemment est celui où cette égalité cesse, ou celui où elle s'établit." This concurs with the phenomena observed in an artificial transit, but in the observation of the actual transit may lead to misconception. The Conference appears to consider the phenomena of the *shade* and *black drop* as distinct and separable, but it is more probable that they are simply stages of the same phenomenon. The phenomena are not always the same, owing to varying atmospheric conditions; assuming, however, that the observations are made with instruments of sufficient power, properly focussed, the only sources of difference would be the different amount of atmospheric tremors, and the different degrees of contrast between the brilliancy of the sun and sky. The greater the tremors and the greater the contrast, the more decided will be the black drop. Observers should confine their attention to the cusps of light and the general outline of the sun and planet. If there is considerable contrast between the sun and the sky, the moment of true contact at ingress is that when light is about to glimmer all the way across the space between the cusps. If the contrast between the sun and sky is much less than usual, the completion of the thread of light may not be noted till some seconds after true contact, but the observers should estimate the moment when the cusps would meet if prolonged. For this, however, no precise instructions can be given. I also regret that exterior contacts should be neglected. The Conference appears to have overlooked the phenomenon of the

line of light surrounding that portion of Venus outside the sun; the observers should be warned not to mistake this line of light for the sun's limb. It is essential that observers should practice with an artificial transit so arranged as to represent the actual phenomena as closely as possible. I have said nothing on the subject of photography, because I could not in a small space add anything of importance to my paper of 1872.

The President said: We are exceedingly glad to receive this communication from Prof. Newcomb, but it would have been more valuable to us if it had been made some time ago. It was not, however, from any oversight on the part of the Committee that up to the present time we have not been in possession of the views of the American astronomers, for last October we drew up and sent to the American and other Governments a provisional list of instructions, with a request that they would send us any suggestions that they had to make. Up to the present time, however, we had not received anything from the Americans except a letter stating that they would give the matter their consideration. I think most of Prof. Newcomb's objections are merely criticisms of verbiage. Most of his difficulties are simply what we have met with over and over again in the work of our Conference. If he could have attended our meetings and exchanged ideas with us, I have no doubt that we should have arrived at an agreement, simply by the alteration of a few words. We shall of course give his views careful consideration, but time is pressing, and probably any alterations which we now make must be final; and I am not sure how far they will be in accord with the American views, as we shall not be able to wait for their reply. There are many points which justify me in saying that Prof. Newcomb's suggestions are mere criticisms of verbiage. For instance, we direct observers to note the continuity or discontinuity of the sun's limb, while Prof. Newcomb wishes their attention to be concentrated upon the cusps; but that is only another way of expressing the same thing. There were certain observers in 1874 who said they saw pure geometrical contact and nothing else. If they saw that, they observed the break of continuity in the illumination of the sun's limb; that is our definition, and we merely say, "give us the time, and it is all we want." There were others who observed with a brighter field, which increased the irradiation, and undoubtedly they would see some disturbance of the light near the point of contact whilst the limbs were apparently at some distance apart If they saw this, if the disturbance was of a marked character, and not simply the result of atmospheric tremor, but something absolute, we say, "give us the time, and it is all we want." Then with regard to the phenomenon of the shadow, or black drop, or whatever it may be called, if you see the break of continuity, give us the time of that

also. We did not suppose these phenomena to be distinct from one another, we believe them to be the same; but when observers give them different names, it is best to say, "Call it what you like, but give us the time when the phenomenon is seen." Then Prof. Newcomb says that we must watch the cusps and the outlines of the sun, and as soon as we think we see the light begin to glimmer all the way across the dark space between the cusps, we must put that down as the time of contact. Well, that is exactly the same thing as we say. It is at ingress the last time you see any distinct and permanent break in continuity of the sun's limb; and therefore I see no real difference in our definitions. With regard to many of these phenomena, they must take place under any circumstances, but it is exceedingly desirable that as far as possible the illumination of the field should be nearly the same, because then there is greater probability of all being able to see the same kind of phenomena. If you use a very bright field, the irradiation is considerable, and with this there are disturbances of a complicated character; and if you will watch them, and note the successive phases, you may put them down for a considerable time before apparent contact at egress. With regard to the definition of the meeting of the cusps, there is no doubt a difficulty, which we have tried to guard against, namely, that the atmosphere around Venus is, comparatively speaking, bright, and when it first comes it will appear as a bright band across the limb, and, if they are not careful, some observers will put it down as contact, whereas, if they waited, they will find that it has become darkened by contrast with the limb, and that a disturbance of the sun's limb is perceptible long afterwards. To avoid mistake on another point, we avoid the use of the phrase, "the first appearance of light at ingress." You may be observing when clouds break suddenly, and you may see Venus separated from the sun, and you might possibly put that down as contact; but it may be that Venus has separated some seconds, and if that time were introduced into the calculations it would destroy the best series of observations ever made. It is necessary, therefore, there should be some "touch" between the limb of the sun and Venus, and you must insist upon observers putting down the time of "touch" and the time they last saw the disturbance; because directly you have lost that there is nothing to guide you, and you may keep on seeing bright lines one after the other. It is on these points that the difficulties occur.

Mr. Christie: I quite agree with Mr. Stone in his general view of this matter, but I do not think it is quite so simple as he has made out. There are great difficulties with regard to the Australian and other colonial observations, because there you have observers

recording all sorts of times, and those times differ by minutes. I think also we occasionally get a different form of contact observed. The question of *atmosphere* has misled observers to a great extent in the last transit, and it seems to me it is to this that attention should be chiefly concentrated, so that observers should not, immediately they see an arc of light joining the cusps, imagine contact is complete. They should describe the phenomenon they see, and record each time. I think the selection of the last time at which an observer sees anything is apt to lead him into difficulties, because there are idiosyncracies in observers. They may record the time when they imagine they see the contact, but you can tell from the discrepancy between the different observations that it was not the time. I think it would be desirable that observers should give one or two times during the progression of the phenomenon, because it is not absolutely instantaneous, and may go on for ten or twenty seconds.

The President asked in what colonial observations Mr. Christie had seen a difference of one minute with regard to first contact. He was not aware of any such discrepancy.

Mr. Christie: I do not mean that the time of the first or last contact differed by a minute, but that there is that interval between the times recorded for the different phases, which is quite another matter. I do not accept their definition of the time of first or last contact; but if they give the times at which they last see something, whatever it may be, it is my impression that these times do sometimes differ by a minute. Sometimes an observer will record, "Venus well on the Sun;" while others will record something else which they last saw. The difficulty is, to get observers to express themselves definitely, because it is not unusual to find the time taken of something which they suspect they have seen, and which turns out afterwards to be a mistake.

The President: If Mr. Christie merely means that when observers give the time of what they call apparent contact and the time of the last or first appearance of the ligament these times differ by minutes, that undoubtedly is the case. In my own observations there was a difference of 56 seconds between apparent contact and what I gave as the first definite formation of the ligament. In these ingress observations there are distinct statements that will enable you to say to which of the phenomena the observer refers. In some cases the observers give two times bracketed together; you can then, no doubt, select which you like best, or more properly adopt a mean, but this is all the range available. You can get these so-called *contacts*, from apparent contact to real contact, extending over a very large interval of time; but if you like to

call things perfectly distinct by the same name, you must not be surprised if you get into a mess.

Mr. Christie: The discrepancy to which I have alluded, and those of which Mr. Stone has spoken, have nothing to do with apparent contact. There is, for instance, in the Australian observations, a phase which is called the "Chinaman's Cap." That is not contact, but it means a ligament; and under ordinary circumstances I should have been surprised to find that the phase occurred perhaps ten minutes before the final rupture of the ligament. I can understand the apparent contact may be one or two minutes before the final rupture of the ligament, and it is this which introduced the difficulty into the problem. The question of 20 seconds is a very serious one in the determination of the parallax.

The President said if they took the average between 20 and 10 seconds it would not produce a very large probable error.

Mr. Rand Capron: On the occasion of the last partial eclipse of the sun, I took some photographs with my small six-inch aperture. At that time the sun of course was very low and there was much atmospheric disturbance, making the sun's limb extremely unsteady, but the photographs were sharp and well defined. I do not know whether that was due to the instantaneous image impressed upon the plate. I should like to know whether the same thing is observable in a succession of instantaneous plates.

The Rev. S. J. Perry: It may be interesting to notice that a series of experiments were made in Paris by M. André, in which he found that the least difference between the *actual* contact obtained by automatic means and the last appearance to be observed was $1\frac{1}{2}$ minutes. With another aperture it was 2 minutes, and with a third aperture between 3 and 4 minutes. There was one phenomenon, however, that always occurred within 2 seconds, The average was $\frac{7}{10}$ of a second from contact; and the greatest error was $\frac{6}{10}$, so that all the observations fell within $1\frac{3}{10}$ seconds. This phenomenon consisted of a *flattening* of the cusps at ingress, and at egress a *rounding* of the cusps; the maximum error in this was not greater than $\frac{1}{3}$ of a second. I am afraid this is too delicate a phenomenon for the day of the transit; but it was one that presented itself every time the model was used.

The President: What were the apertures?

The Rev. S. J. Perry: I think a 6-inch, and a 4-inch, and another of $2\frac{1}{2}$. Professor Newcomb would discard the spider lines 1 second apart, which are to be used for securing uniformity of illumination, but he would, I am afraid, introduce very serious errors by admitting such a variety of illumination as he proposes. MM. André and Hatt found they could get the black drop

just as they liked by varying the illumination. By varying the illumination you could destroy the black drop as it formed, and so get an instantaneous geometrical contact. In regard to external contact, it seems to me that the Americans rely very much upon it, mainly on account of their success with their model. M. André, however, made experiments upon this and always found from 12 to 17 seconds off external contact, though the eye was not fatigued as it would be in the real contact. Of course it will be a good thing to observe external contact; but I do not think it is so valuable as internal contact, because we are uncertain as to the effect of irradiation or diffraction in external contact. Again, in regard to the atmosphere of Venus. The American observations at the last transit give but little explanation. Some observers say that there was something very doubtful; others who were more certain simply call it "contact," but what they mean by "contact" they do not explain. The British astronomers were told to give full explanations In Lieut. Corbett's observations, for instance, you can tell exactly what he saw and follow each phase. Again, if observations are made with the double-image micrometer, you will see two things formed at the same time, and I think this will catch the eye more readily than if you simply watch the encroachment of the planet on the sun. The double-image micrometer should not be used up to the last moment, as was done in some of the last observations, by which some of the best were lost. Major Tupman and Mr. Nicholl, at Honolulu, looked for contact about 1 minute before it took place and saw the atmosphere of Venus for the first time, but fortunately Major Tupman kept his eye at the telescope and saw what he considered real contact. The atmosphere of Venus may be seen considerably before contact, and all observers describe it as differing from the brilliancy of the sun; a good observer will be able to detect the difference. At ingress you will have the atmosphere coming in apparent contact with the sun's limb, and afterwards the dark ligament may form behind this atmosphere. I think we must be prepared for a greater amount than 20 or 30 seconds between the actual contact and the last appearance of the well-defined ligament —that is, between the real contact and what is to be observed—but previous to that you will have a change in the illumination which I think myself is of very great importance in the formation of this black drop. I think we ought to be very careful to observe this as well as the last appearance of the ligament.

The President: One remark as to experiments with the models. Do what you will you have nothing like the phenomenon presented in the actual transit. I see Captain Abney present, and perhaps he can answer the question put by Mr. Rand Capron?

Captain Abney: It may happen that when the atmosphere is in a great state of vibration very sharp photographs may be obtained with instantaneous exposures; but it is a "toss-up," if you expose for the 2,000th part of a second whether you get sharp or undefined edges. Of course, with an exposure of the 120,000th part of a second, better definition will be obtained.

Mr. Christie read a paper by Lieutenant W. U. Moore, on alleged errors in the time record of the observations of the transit of Venus, 1874, at Hermitage, Rodriguez. Mr. Christie explained that Lieutenant Moore had only just seen Sir G. Airy's Parliamentary Report, and further that Lieutenant Hoggan's original observation read 6h. 35m. 37s., but that it had afterwards been altered to 6h. 34m. 57s. If this observation was altered back to the original figures, no further change would be necessary.

Mr. Green, in reply to the President, called attention to the recent drawing of the planet Mars, made by Professor Schiaparelli, in which most of the "canals" were represented as double. Mr. Green said, I have compared a photograph of this drawing with drawings made by the Rev. Mr. Dawes, and found that nearly all the lines, which Proctor has referred to in his letter to the *Times*, do not exist in Professor Schiaparelli's drawing. Therefore, though Mr. Dawes saw them, they have disappeared. Some small lines also, shown in drawings by Mr. Banks of Ealing, do not appear in the drawing of Schiaparelli. In one of Mr. Burton's drawings there are delicate markings, which however cannot be reconciled with the drawings made at another time. All these appearances require great caution. They should not be recognised as facts until other observers have seen repetitions of the same phenomenon. I have been careful not to put anything in my own drawings until it has been seen over and over again. I believe Mr. Maunder has made drawings which show some markings similar to those of Schiaparelli; therefore, we must not conclude that there are no such markings as Schiaparelli has seen, but we must be careful how we regard them as permanent markings on the planet.

Mr. Maunder: I have observed Mars six or seven times during the last opposition. Some of the spider-like markings observed, seem to correspond roughly with Schiaparelli's 1879 observations. My drawings of the same district, however, on different nights do not perfectly agree in regard to the canals, but I have been generally able to make out the stronger markings which Schiaparelli has delineated. One delicate marking I have seen repeatedly under favourable circumstances. At the same time, I have noticed that other observers frequently show the beginning, and what might be the ending, of the canals of Schiaparelli, but not the middle

parts which Schiaparelli has drawn. I think also that in many cases what he has represented as canals are rather boundaries of delicately shaded regions.

Mr. Knobel: In some drawings which I made in 1879, there were confirmations of some of Schiaparelli's markings which I do not find recorded in Mr. Green's map; I have also distinct markings on three different nights, which neither appear in Schiaparelli's drawing nor on Mr. Green's map.

Mr. Rand Capron: I think that allowance must be made for discrepancies between drawings made by the eye. Until accurate measures have been made of these canals the observations are not of great value as to their form.

Mr. Green pointed out that unless the observer sometimes knew what to expect, he might easily be misled.

The President read a paper on some of the results obtained from the meridional observations of Mars made at the Cape of Good Hope, Melbourne, Leyden, and Washington, from which a value for the solar parallax of 8″·95 was deduced; a result not greatly differing from that which had been obtained by Prof. Eastman.

Mr. Downing: I think that the meridional method is an excellent one, but that during the 1877 opposition of Mars it has not received fair play. In the northern observatories, Washington and Leiden, they used two parallel wires to cut off an equal portion of the planet's disc north and south, whereas at the Cape and Melbourne a single wire was employed. It was possible that this difference introduced a systematic error. The comparison of the observations at Leiden and Melbourne, in 1877, gave a different value of the parallax before and after opposition. Mr. Downing asked if Mr. Stone had discovered any difference in the observations made before and after opposition.

The President said he saw no difference. He did not think that any large systematic error depended on the use of a single or two wires.

The following papers were also announced:—

D. Gill: *On the best mode of undertaking a discussion of the observations of contact to be made at the approaching transit of Venus.*

E. J. Stone: *Note on Mr. Neison's paper on the corrections to Adams's semi-diameter of the Moon.*

REVIEWS.

Cincinnati Observatory. Micrometrical Measurements of 455 *double stars observed with the* 11-*inch refractor during the year ending September* 1, 1880, under the direction of Ormond Stone, A.M., Astronomer. Cincinnati: Published by authority of the Board of Directors of the University. 1882. pp. 69.

Double-star measurements are assiduously prosecuted at the Cincinnati observatory, where a fine telescope is skilfully employed by the Director and his able assistants, Messrs. H. A. Howe and H. V. Egbert. The present number (6) consists partly of the results of observations preliminary to the preparation of a general catalogue of known double stars, situated between the equator and 30° south declination, and partly of observations of double stars which Mr. Burnham has found to need re-observing. The number of observations is 700, binaries and some others having been observed twice or oftener. No. 4, published in 1878, contains measurements of 517, and No. 5, 1879, of 1,054 stars. The eye-pieces employed latterly seem to have been principally, A (400 power), and III. (230), and occasionally VI. (920). Notwithstanding that the objective (by Alvan Clark and Sons) has many veins, its defining power, since it was re-figured by its makers, is stated to be excellent, though leaving something to be desired as to achromatism.

Comets. A Discourse by William Huggins, Esq., D.C.L., LL.D., F.R.S., Correspondent of the Institute of France, &c., &c. Delivered at the Royal Institution, January 20, 1882.

Ably and with his accustomed caution, Dr. Huggins expounds in this lecture the results of his own and others' latest researches on the nature of comets. The paper is accompanied by a plate of the photograph of the spectrum of the head of comet *b*, 1881, obtained by himself, and a diagram illustrating Bredichin's theory of the various curvatures of comets' tails. Dr. Huggins is careful to draw the line firm between facts and fancies, and not to commit himself on what he terms the "enchanted region of speculation." Thus observing that "there seems to be a rapidly growing feeling among physicists that both the self-light of comets and the phenomena of their tails belong to the order of electrical phenomena," and that this appears to be the prevailing impression among American astronomers, he says, "Here I confess I tread most cautiously, for we have no longer any stepping-stones of fact on which to place our feet." This paper is an excellent summary of the knowledge which in recent years has been gained of comets by the use of the spectroscope, and from mathematical investigation in relation to periodical meteor streams.

L'Astronomie. *Revue mensuelle de l'Astronomie Populaire, de Meteorologie et de Physique du Globe.* Publiée par Camille Flammarion, avec le concours des principaux Astronomes Français et étrangers. Paris: Gauthier-Villars, Imprimeur-Libraire de l'Observatoire de Paris, Quai des Augustins, 55. 1882.

The contents of the first number of this new monthly astronomical journal are: Preliminary Address, the Paris Observatory, with two illustrations, Comets, with a map of the path of the great comet of 1881, showing its varied appearances to the naked eye from June 23 to Sept. 4, Lunar Scenery, with illustration. Communications to the Academy of Sciences, and Scientific News. Varieties, the heavens in March, 1882,

with planisphere. and forthcoming observations of interest. This Review is to appear on the first of each month, and will consist of from 32 to 40 pages large 8vo. The annual subscription for this country is 14 francs, which can be paid to M. Gauthier-Villars, at the above address. Communications should be forwarded to M. Camille Flammarion, 36, Avenue de l'Observatoire, à Paris. The matter, the printing, the paper, and the illustrations of this journal are all good, and we have no doubt that it will have abundant success. It is intended for general readers as well as astronomers.

Annuaire de l'Observatoire Royal de Bruxelles 1882. 49e Année. Bruxelles: F. Hayez. 1881.

The present number of this excellent serial contains a long article on the solar spots by René Tamine, Sous-Ingénieur. His theory is that the spots are owing to streams of meteorites falling into the sun, by which he endeavours to explain the various phenomena connected with the spots, faculæ, and protuberances. Of the last mentioned he says the rapidity of their formation and disappearance, their extreme mobility and enormous velocity show that they cannot be formed by vapours expelled from the interior of the body, but they are occasioned by electric discharges due to a special disturbance taking place on the sun's surface. The theory is intermediate between that of Kirchhoff, and of those astronomers who regard the spots as cavities. The clouds of Kirchhoff would be the meteoric currents reduced to the condition of vapour, contained in a cavity which they have formed in penetrating the photosphere. Planetary influence, M. Tamine regards as indirect, the planets modifying the orbits of the meteorites which circulate round the sun, and occasion the spots by falling into it. This is a well-considered article, and deserves attention.

There is also a paper by M. Houzeau, the editor, on the history of algebra, from its rise in India with Aryabhatta, through the Greeks, Arabians, Italians, French, English, and Germans. M. Houzeau specifies three distinct epochs in the history of algebra. 1. A general arithmetic, such as the algebra of the Hindoos, Greeks, Arabians, and Italians, and still used by the Chinese. 2. Operations on symbols which are not numbers but *letters*, and applicable to all sorts of magnitudes; such was the algebra of Vieta and his immediate successors. 3. The work of Descartes on the geometric expression of the relations between quantities. After this the whole attention of analysts was directed to these material representations of the laws existing amongst magnitudes, and the infinitesimal calculus was invented to investigate the properties and the combinations of curves.

Thirty-sixth Annual Report of the Director of the Astronomical Observatory of Harvard College. By Edward C. Pickering. Cambridge, University Press: John Wilson & Son, 1882. pp. 16.

We notice with satisfaction that six ladies have taken part in the reductions of observations with the equatorial, meridian circle, and meridian photometer. A large photometer with 4-in. object-glasses, and capable of measuring any star brighter than the tenth magnitude, is in preparation. The large telescope has been employed in the photometrical observation of the eclipses of Jupiter's satellites, the search for objects having singular and banded spectra, and the photometric study of β and ω Persei, and D. M. 81° 25′ and 26′. Six comets have been observed, and the observatory has taken an important part in the early

distribution of circulars relating to the comets recently discovered, by defraying the cost of telegrams, and by furnishing the necessary observations and computations. In co-operation with the Dun Echt Observatory and the *Science Observer*, circulars have been distributed in Europe and America giving an early announcement of the elements and ephemerides of the five new comets discovered in 1881. The computations have been generally made by Mr. Chandler, who has not hesitated, whenever necessary, to continue them through the entire night. With the meridian circle 3,202 observations have been made of Polaris, the sun, polar stars, fundamental stars, and miscellaneous objects. Investigation of the errors of the fixed circle has been made with a metal plate having an arc of 15° subdivided to 5′. It was found that the accidental errors of division rarely reach 1″. Since the last report considerable progress has been made with the reduction of the zone observations. With the meridian photometer about 76,002 observations have been made in all. 36,000 since Nov. 1, 1880. A comparison of the photometric observations with those made by the naked eye (aided when necessary by an opera-glass) is being carried out; the total number of comparisons required for this work is about nine thousand, of which nearly a quarter have already been made.

Volume XIII. of the Annals is in process of publication. A list is given of the various valuable papers which have been communicated during the year by officers of the observatory. An important work on variable stars is in preparation by Mr. Chandler. The new meridian photometer will be used for measuring variable stars and their comparison stars, and also for determining the light of the brighter asteroids. The above (and we have left much unnoticed) amply testifies to the unabated zeal, the good judgment, and the ability with which work is carried on at Harvard Observatory.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

LUNAR CLEFTS.—MARS, &c.

My dear Sir,—I send you the following miscellaneous notes which I have lately made:

1882, Feb. 24, 5½h. to 6½h. G.M.T. Cleft of Ariadeus. I suspected that the following end was bifurcated, forming two excessively delicate clefts inclined some 35° or 40° to the direction of the principal cleft.

March 24, 6½h., and again from 8h. 25m. to 9h. 10m. G.M.T.

Large cleft in Janssen. This begins under the wall of Fabricius, traverses Janssen closely under and to the east of a remarkable bluff, which is apparently rendered steeper by the neighbourhood of the cleft. Then it becomes somewhat shallower, and terminates by a spoon-shaped expansion close to the foot of the S.E. rampart of Janssen. Some distance to the westward of this hollow, it receives two somewhat narrow clefts from W. and S.E. The first of these branches is approximately parallel to the neighbouring rampart, but just before joining the main cleft it curves to the northward. The real breadth of the principal cleft is probably at least double that of the branch just described. The edges are very rough, apparently by reason of the presence of innumerable buttresses, dykes, or overhanging crags. I repeatedly suspected a short ridge (3″ or 4″ in length), lying parallel to the axis of the cleft, a little to the northward of the point, where it approaches nearest to the bluff before mentioned. Another cleft extends southward from the outer slope of Janssen, and is apparently a continuation of the great cleft just described. None of these are described by Mädler.

March 29, 8h. to 9½h. G.M.T. The great cleft of Capuanus (with outliers) = 65 + 67 of B. and M. To the description in Neison's "Moon," it may be added that this cleft passes through two small craters lying on opposite sides of a ridge N. of Cichus in a manner peculiar to each, and probably dependent on a difference in their materials. No decided change visible with the then illumination is produced on the W.—a bright craterlet—but the other, which lies close to (about one diameter from) the eastern foot of the ridge in a dark patch, and is itself dark, has its wall broken down at the points where the cleft intersects it.

At this time and again two hours later (10h. 25m. to 10h. 35m. G.M.T.) I became almost certain of a connection between the Capuanus cleft, and a bifurcated cleft to the N.E. belonging to the cleft system of Ritter, by an excessively delicate and smoothly curving cleft.

On the same night a short cleft, running northwards from Cichus C towards the Capuanus cleft, was more distinct than the latter, though seemingly not mentioned by Neison. Change was suspected here by the Rev. T. W. Webb, and it is hard to understand how the cleft in question can have been missed by B. and M. or by later authorities.

Canals of Mars.—Owing to circumstances beyond my control, Mars was not observed until Feb. 15, between which date and March 13 the following dusky streaks ("canals") were seen and identified: The Lethe, Astapus, Astaboras, Phison (northern half), Nilus, Indus (to the angle) and Oxus. The dark shading in the G. Syrtis (Kaiser Sea and Dawes Ocean) inclined to the *f* side, not to *p*, as seen at Milan. There was an immense amount of minute and complex detail (interlacing lines) at the junction of the G. Syrtis and Nilus (Kaiser Sea and Nasmyth Inlet). The "canal" from Sinus Margaritifer (Beer Bay) did not fuse with the point of the bay, which was sharply defined and of a deep tone, as in '79. A 9-in. mirror, with powers of 270 and 600 was used for all the above observations.

Faithfully yours,

Loughlinstown, Co. Dublin: C. E. BURTON.

1882, April 19.

CLEOMEDES A.

Sir,—In "Lunar Work for March, 1882" (*Astronomical Register*, No. 231, p. 71), the Rev. Dr. Richards kindly refers to an observation of mine of *Cleomedes* A, as corresponding very nearly with some of Schröter's observations. Since the date of my note this object has been examined on several somewhat favourable occasions, and the reason why *Cleomedes* A is not visible as a crater for some time after sunrise seems to be pretty clearly established. The following three observations may serve to clear up this point.

1882, Jan. 22, 5h. 30m. Age 3·0 days. 2·75-in. achrom., power 102. The S.W. wall of A2 was extremely lofty and prominent, and appeared continuous with the west wall of *Cleomedes* A. The north wall of this latter was visible distinctly, but the east and south-east were obliterated by the shadow cast by the lofty S.W. wall of A2.

Jan. 23, 6h. 30m. Age 4·1 days. $5\frac{1}{4}$-in. Calver, p. 110. *Cleomedes* A and A2 appeared almost exactly as on Jan. 22, but the former was not so much hidden in shadow. Its ring was thin and bright, the S.E. portion being cut off by the huge towering height of the S.W. wall of A2, which was by far the most prominent object on the floor.

Jan. 24, 7h. 15m. Age 5·1 days. $5\frac{1}{4}$-in. Calver, p. 110. The S.W. wall of A seemed continuous with that of A2, the S.E. wall was visible, but was extremely narrow on account of the shadow cast by A2.

These notes seem to show pretty clearly that the reason of the crater A not being visible, as such, until some considerable time

has elapsed after sunrise, lies in the fact of its east and south-east walls being then hidden in the shadow cast by the S.W. wall of A2, and perhaps also by the S.W. wall of A itself. This explanation, however, is somewhat at variance with the fact that shortly before sunset the shadow of the south-west wall of A2 falls on the S. wall of A to the west of A2, showing it to be situate at a lower level, and in this position it could not well be observed by the shadow of A2 at sunrise.

This object would, therefore, still seem to require special attention, not only to clear up this point, but also to describe exactly the minute detail of the two craters A and A2. There seems to be little or no wall on the east of the latter, though it is much depressed below the surrounding surface. There can be no doubt about the fact of the crater A being of much more recent formation than A2.

West Brighton: Yours faithfully,
April 12, 1882. A. STANLEY WILLIAMS.

LUNAR WORK FOR MAY, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Mare Crisium. The Rev. F. B. Allison observing this region on March 22, at 7h., noted that the ridge *Picard* λ is forked south of *Peirce A*, and that it does not quite reach *Cleomedes F*. He also saw a second fork in the ridge λ east of *Peirce*. I do not remember to have seen these forks mentioned in any previous observation, nor do they occur in any drawings that I have at hand, though something like a fork is shown in a drawing by Gaudibert (in the *English Mechanic* of June 1, 1877) on the ridge λ, between *E* and *K*. But this is too far south for the one mentioned by Allison.

These low ridges have been much neglected by observers, and hardly any accurate drawings of them seem to have been made; most drawings that I have seen differ widely from one another. And yet the low ridges on the surface of the *maria* have an interest of their own, and are probably to be classed among some of the more recent of the lunar formations.

Peirce A. Several observers have from time to time been unable to see *Peirce A*, on account of a bright streak from Proclus that seemed to pass over it. Mr. Allison, who has paid great attention to this point, has observed *Peirce A* every time that he has looked at the moon when the crater was illuminated since December, 1879. He has never failed to see it with his 4½-in. telescope, though he has at times found it very difficult with a 3-in. glass at about the ninth day of the moon.

Mare Nectaris. Two undulating ridges run parallel with the border of the *mare*, and connect the eastern and western sides of Beaumont with those of what seemed to me (1882, March 24) to be a shallow ring outside Theophilus on the south-west. This ring is not shown by Neison or Beer and Mädler. Has any other observer noticed it?

St. Mary's, Bayswater:
April 19, 1882.

District Catalogue of Picard.

N.B.—The origin of the measures is the centre of Picard. The unit of distance is $\frac{1}{121}$ of the moon's diameter.

Mountains, elevations, and bright spots are indicated by *Greek* letters and *odd* numerals.

Craters, depressions, and dark spots by *Roman* letters and *even* numerals.

Name.	*Objects.*	P.	D
Picard	Ring plain 21·3 miles in diameter. Lat +14° 27′ 4″, long. +53° 52′ 8″		
A	(*Peirce*) small ring plain. Lat. +18° 8′, long. +52° 20′	20	3·5
A 2	Minute crater on south part of floor of *A*		
A 4	Minute crater on exterior of W. wall of *A*		
B	(*Peirce A*) small ring plain. Lat. +19° 9′, long. +52° 23′	20	4·6
d	Crater near north border of *H*	140	1·5
E	Crater on or joining the ridge λ, west of the "Pass"	55	2·6
f	Craterlet on the west of the Pass	80	2·1
G	A bright crater in lat. 9° 40′ N., long. 52° 37′ W.	180	4·3
g	A small crater W. of *H*	165	2·0
H	Schröter's ancient ring near S.E. border	155	2·0
h	A small crater west of *g*	175	1·8
i	A small crater west of *θ*	330	3·0
K	An ancient ring between Picard and the Pass	100	1·3
k	A small crater west of *h*	190	1 6
l	A minute crater between *K* and *d*	125	1·4
m	A minute crater south of *n* [on *μ*]	260	1·2
n	Craterlet W.S.W. of *Picard*	280	1·1
p	A small crater N.W. of *Picard*	335	1·6
q	A small crater nearly north of *Picard*	15	1·8
q 2	A minute crater nearly north of *Picard*		
r	A small crater E.N.E. of *s*	205	3·8
s	A small crater east of *t*	210	4·3
t	A small crater near the S. border of *M. Crisium*	220	4·1
u	A small crater N. of *t*	220	3·8
w	A small crater S. of *Peirce*	30	2·5
x	Small crater E. of *Peirce*, near east border of *M. Crisium*	40	4·1
α	A peak on the east border of the *M. Crisium*	170	3·0
β	A peak on the border of the mare, east of *α*	150	3·0
γ	A peak on λ, aligning *E* : *γ* : *B* (it is Schröter's *m*)	55	3·5
δ	A peak W. of λ, N.E. of *E* (it is Schröter's *n*)	60	4·0
θ	Schröter's forked ridge (the fork	240	2·0)
θ 2	Crater on west branch of *θ*	218	3·4
θ 4	Crater on east branch of *θ*	220	2·4
θ 6	Small crater on west branch	230	3 0
θ 8	Crater on *θ*, north of the fork	305	1·9
θ 10	Small crater on east branch	200	2·8
λ	A ridge connecting *d*, *K*, and *E*		
π	A peak N. of *δ* (it is Schröter's *p*)	25	4·1
μ	A bright spot west of Picard, enclosing *m* and *n*	270	1·1
Picard 1	A minute point just S. of Picard	180	

N.B.—Anyone desirous of a tracing of the key plan of the district may obtain one by application to the Rev. Dr. Richards at the above address.

LONGITUDE OF THE MOON'S TERMINATOR at MIDNIGHT.

N.B. — Means East. + West. M., Morning Terminator.
E., Evening Terminator.

1882.		° ′			° ′	
May	1	−78 16	M.	17	+86 22	M.
	2	+89 31	E.	18	74 9	
	3	77 19		19	61 56	
	4	65 7		20	49 44	
	5	52 54		21	37 30	
	6	40 42		22	29 18	
	7	28 29		23	17 5	
	8	16 16		24	4 52	
	9	4 4		25	−11 21	M.
	10	− 8 9	E.	26	22 35	
	11	20 21		27	35 47	
	12	32 33		28	48 0	
	13	44 47		29	60 13	
	14	57 0		30	72 26	
	15	69 12		31	84 40	
	16	81 25				

Moon nearest the earth ... May 12, 15h.
„ farthest from the earth „ 24, 21h.

DUN ECHT CIRCULAR, No. 49.

From the observations on March 19, 21, and 23, already given in these circulars, Mr. Hind finds the subjoined elements and outline path of the comet.

Elements.

$$\begin{aligned} T &= 1882, \text{ June } 15{\cdot}0345 \text{ Greenwich M. T.} \\ \pi &= 49^\circ\ 8'\ 24'' \\ \Omega &= 205\ \ 19\ \ 46 \\ i &= 73\ \ 45\ \ 1 \\ \log q &= 9{\cdot}003769 \end{aligned} \left.\begin{matrix} \\ \\ \\ \\ \\ \end{matrix}\right\} \text{App. Equinox 1882, March 21.}$$

Direct.

Ephemeris for 12h. G.M.T.

1882.		α h. m. s.	δ °	log. Δ	I.
April	15	18 53·2	+52·1	0·105	2·9
May	5	21 12·0	71·2	0·010	7·8
	25	3 21·2	64·5	9·972	24·9
June	4	4 25·2	48·0	9·987	62·5
	14	5 12·0	22·9	0·032	934·8
	24	7 30·8	8·9	0·016	64·3
July	4	9 7·6	+ 4·3	0·070	17·1

The intensity of light, I, at the Dun Echt observation March 23 = 1.

Mr. Hind remarks—"The heliocentric arc described is less than 25′, so that this orbit can give only a general idea of the true one, or of the future path of the comet."

Partly from the same observations, Dr. M. W. Meyer, of Geneva, has also deduced an orbit of which the elements are:

$$T = 1882, \text{ July } 51{\cdot}040, \text{ Berlin M. T.}$$
$$\left.\begin{aligned} \pi &= 307^\circ\ 43'{\cdot}8 \\ \Omega &= 205\ \ 28{\cdot}2 \\ i &= 70\ \ 47{\cdot}9 \end{aligned}\right\} \text{ Mean Equinox } 1882{\cdot}0$$
$$\log q = 6{\cdot}31522$$

The representation of the middle place is:

$$\cos\beta\,\Delta\lambda = +4''; \qquad \Delta\beta = +44''.$$

Lord Crawford's Observatory, Dun Echt: 1882, March 31. RALPH COPELAND.

DUN ECHT CIRCULAR, No. 50.

Elements and Ephemeris of Comet Wells.

see also April No p 9

From March 19, Harvard College.
" 23½ (Berlin+Leipzig).
" 27 Geneva.

$$T = 1882, \text{ June } 16{\cdot}6190.$$
$$\left.\begin{aligned} \pi &= 48^\circ\ 34'\ 21'' \\ \Omega &= 207\ \ 11\ \ 14 \\ i &= 75\ \ 11\ \ 19 \end{aligned}\right\} \text{ Mean Equinox, } 1882{\cdot}0.$$
$$\log. q = 9{\cdot}07186$$

$$\Delta\lambda\cos\beta = +4''; \qquad \Delta\beta = 0''.$$

Ephemeris for Berlin Midnight.

1882.	α h. m. s.	δ ° ′	log. r	log. Δ	I.
April 6	18 28 53	+44 43·4	0·1606	0·2503	2·14
7	31 14	45 29·4			
8	33 41	46 16·2			
9	36 13	47 3·9			
10	38 50	47 52·5	0·1386	0·2323	2·57
11	41 32	48 42·0			
12	44 21	49 32·4			
13	47 16	50 23·6			
14	50 19	51 15·7	0·1168	0·2134	3·10
15	53 30	52 8·7			
16	56 49	53 2·5			
17	19 0 18	53 57·1			
18	3 58	54 52·5	0·0957	0·1932	3·75
19	7 50	55 48·7			
20	11 55	56 45·5			
21	16 15	57 43·0			
22	20 51	58 41·1	0·0753	0·1716	4·55
23	25 45	59 39·7			
24	30 59	60 38·7			
25	36 35	61 38·1			
26	19 42 35	+62 37·7	0·0562	0·1483	5·53

The brightness, *I*, on March 19 = 1.

Dr. H. Oppenheim. Berlin, March 30, 1882.

From the American observation March 19, and Kiel observations March 22 and 25:

$$\begin{aligned} T &= 1882,\ \text{June } 12{\cdot}07195,\ \text{Greenwich M.T.} \\ \pi &= 52^\circ\ 6'\ 33'' \\ \Omega &= 204\ \ 59\ \ 33 \quad \text{App. Equinox 1882, April 0.} \\ i &= 73\ \ 42\ \ 44 \\ \log.\, q &= 8{\cdot}870371. \end{aligned}$$

$$\Delta\lambda \cos\beta = +6''{\cdot}7; \qquad \Delta\beta = +1''{\cdot}0\ (\text{O—O}).$$

If I, March 19 = 1 }
I, June 12·0 = 2105 } ? A daylight-object at this time!

Twickenham: 1882, March 31. J. R. HIND.

Lord Crawford's Observatory,
Dun Echt: 1882, April 3.

ECLIPSE OF THE SUN.

A total eclipse of the sun, partially visible at Greenwich, will take place on May the 16th.

	Greenwich Mean Time. h.	m.
Beginning of the eclipse, May 16... ...	18	10·5
Greatest phase	18	46·0
End of eclipse	19	23·0

Magnitude of the eclipse (sun's diameter = 1) 0·186.

THE PLANETS FOR MAY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	... ...	...	...	23 57·9
	9th	3 39 2	N.20 38	5″·2	0 30·2
	17th	4 45 54	N.24 26½	6″·0	1 5·4
	25th	5 42 23	N.25 38	7″·0	1 30·3
Venus ...	1st	3 44 58	N.20 2½	10″·2	1 7·5
	9th	4 25 58	N.22 15	10″·4	1 17·0
	17th	5 7 57	N.23 47	10″·6	1 27·4
	25th	5 50 33	N.24 36	11″·0	1 38·4
Mars ...	1st	7 55 34	N.22 42	7″·0	5 17·5
	9th	8 13 4	N.21 44	7″·6	5 3·5
	17th	8 30 48	N.20 38½	6″·4	4 49·7
	25th	8 48 41	N.19 25½	6″·2	4 36·1
Uranus ...	1st	11 4 31	N. 6 48	3″·8	8 25·9
	17th	11 3 51	N. 6 51½	3″·8	7 22·3

Mercury sets nearly with the sun at the beginning of the month, and afterwards later each night, the interval increasing to over two hours.

Venus may be observed for an hour and three quarters after sunset on the 1st, the interval increasing.

Mars sets about an hour and a half after midnight, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR MAY, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. α Libræ —
Mon	1	19	Superior conjunction of Mercury and Sun Sidereal Time at Mean Noon 2h. 37m. 14·99s.			12 5·2
Tues	2	20 30	○ Full Moon Sun's Meridian Passage 3m. 9·97s. before Mean Noon			12 1·2
Wed	3	8 25 19	Occultation reappearance of ι^2 Libræ (5½) Conjunction of Saturn and Mercury 2° 22′ N.			11 57·3
Thur	4	10 10 10 36 3 20	Occultation of B.A.C. 5395 (6) Reappearance of ditto Conjunction of Neptune and Mercury 2° 3′ N. Conjunction of Jupiter and Venus 0° 59′ N. Saturn's Ring: Major axis=36″·83 Minor axis=13″·48			11 53·4
Fri	5	20	Conjunction of Saturn and Sun			11 49·4
Sat	6	12 39 13 34 11	Occultation of 14 Sagittarii (6) Reappearance of ditto Conjunction of Neptune and Sun			11 45·5
Sun	7	16 20	Near approach of *d* Sagittarii (5)			11 41·6
Mon	8					11 37·6
Tues	9					13 33·7
Wed	10	0 34	☾ Moon's Last Quarter			11 29·8
Thur	11	1	Conjunction of Neptune and Saturn 0° 22′ S.			11 25·8
Fri	12	21	Conjunction of Jupiter and Mercury 2° 16′ N.			11 21·9
Sat	13					11 17·9
Sun	14		Sidereal Time at Mean Noon 3h. 28m. 30·21s.			11 14·0
Mon	15		Illuminated portion of disc of Venus=0·931 Illuminated portion of disc of Mars=0·912			11 10·1

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. α Libræ
Tues	16	19 32 5	● New Moon Conjunction of Moon and Saturn 3° 16′ S. Eclipse of the Sun			11 6·2
Wed	17	13	Conjunction of Moon and Jupiter 0° 0′ Sun's Meridian Passage 3m. 50·37s. before Mean Noon			11 2·2
Thur	18	4 13	Conjunction of Moon and Mercury 3° 33′ N. Conjunction of Moon and Venus 2° 45′ N.			10 58·3
Fri	19					10 54·4
Sat	20					10 50·4
Sun	21					10 46·5
Mon	22	12	Conjunction of Moon and Mars 6° 46′ N.			10 42·6
Tues	23					10 38·6
Wed	24	12 41 8 42 9 53	☽ Moon's First Quarter Occultation of 19 Sextantis (6) Reappearance of ditto Saturn's Ring: Major axis=36″·97 Minor axis=13″·94			10 34·7
Thur	25	7 25 8 12	Occultation of 55 Leonis (6) Reappearance of ditto			10 30·8
Fri	26					10 26·8
Sat	27	9 42 10 13	Occultation of B.A.C. 4201 (6) Reappearance of ditto			10 22·9
Sun	28					10 18·9
Mon	29	13 3 13 35 21	Occultation of B.A.C. 4700 (6) Reappearance of ditto Conjunction of Jupiter and Sun			10 15·0
Tues	30					10 11·1
Wed	31					10 7·2
JUNE Thur	1					10 3·1

Books received.—Observations upon the Temperature, Pressure, and Rainfall of the Past Winter. By C. L. Prince.—L'Astronomie. Nos. 1 et 2. Par Camille Flammarion.—On Comet II. 1881. By John Tebbutt. —Ciel et Terre. No. 3. Bruxelles : Xavier Havermans.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Dec., 1881.
Langley, Prof. J. P.

To Sept., 1882.
Harrild, R. E.

To Dec., 1882.
Green, G. W.
Green, N. E.
Herschel, Major J.
Shaw, Rev. J.

To Dec., 1883.
Fry, E. A.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 234. JUNE. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1882—83.

May 12th, 1882.

E. J. Stone, Esq., *President* in the Chair.

Secretaries—J. W. L. Glaisher, Esq., and E. B. Knobel, Esq.

The minutes of the previous meeting were read and confirmed.

Among the presents which had been received since the last meeting, Mr. Knobel called attention to an important volume which had been received from the Argentine Observatory, containing zone observations made during the year 1872, under the direction of Dr. Gould.

Henry George Hollingworth, Esq., 319, Vauxhall Bridge Road;
Samuel Okell, Esq., Bowden, near Manchester;
William Barrett Roué, Esq., 165, Whiteladies Road, Clifton, Bristol; and
Hesketh Goddard Williamson, Esq., Shrigley Road, Bollington, near Macclesfield,

were balloted for and duly elected Fellows of the Society.

Mr. Downing read a paper entitled *A discussion of the observations of γ Draconis made with the Greenwich Reflex Zenith Tube during the years* 1857 *to* 1875 *inclusive.* The writer said: Mr. Main published in vol. xxix. of the *Memoirs* of the Society a discussion of the observations with the Reflex Zenith Tube

from 1852 to 1859, deducing a value for the constant of aberration of $20''\cdot335$, which was more than a 10th of a second less than Struve's value, while the annual parallax deduced for γ Draconis was $-0''\cdot242$. These results did not appear satisfactory, and I have therefore undertaken a re-discussion of the observations, commencing from the time when the instrument was brought into its present improved position, and I conclude with 1875, so as to include a complete revolution of the moon's node. A value for the constant of nutation may therefore also be deduced, and as many observations have been made during the period, probably a good value of the constant of aberration. My discussion gives the following results:—

Constant of aberration	$20''\cdot378 \pm 0''\cdot040$
Ann. parallax of γ Draconis	$-0''\cdot131 \pm 0''\cdot041$
Constant of nutation	$9''\cdot3353 \pm 0''\cdot0323$

It will be seen that the parallax still comes out a minus quantity, and as it is three times greater than the probable error, we cannot consider it accidental. It is, however, smaller than the quantity found by Main, while the constant of aberration is larger. There is probably a periodic error which may perhaps arise from the effect of temperature on the instrument.

The President: We are very much indebted to Mr. Downing for discussing these observations; for it is of no use accumulating observations year after year unless they are discussed. The negative quantity that Mr. Downing obtains for the parallax appears to be much smaller than the values found by Mr. Main. There is a little doubt thrown upon the value obtained for the constant of aberration when the parallax comes out a negative quantity, but it is exceedingly desirable that these observations should be discussed.

Mr. Glaisher read a paper by Mr. T. W. Backhouse, *On the nebula near Merope*, in which the author stated that with a power of 38 on his $4\frac{1}{4}$ in. refractor he had no difficulty in finding the nebula, which appeared to him very similar to that represented in Signor Tempel's drawing in the *Monthly Notices*, Vol. XL. p. 622. He had not previously read any description of the nebula, and did not even know which star was Merope. He found it necessary to have Merope out of the field.

Mr. Newall: Will you allow me to show on the black-board what I have seen of Merope?

[Mr. Newall made a sketch of the nebula on the black-board. The sketch was somewhat similar to that of Maxwell Hall in the *Monthly Notices*, Vol. XL. p. 169, but extended to about twice the distance from Merope.]

Mr. Common: I have never seen it like that, but more like this.

[Mr. Common sketched on the black-board a drawing something like Mr. Newall's, but inverted.]

Mr. Newall's drawing seems to be upside down. (Laughter.) Has Mr. Newall seen it with an inverting eye-piece or an ordinary astronomical eye-piece?

Mr. Newall said the latter, and the observation was made in 1877, or thereabout, and had often been repeated.

Mr. Common: Then I shall only be able to come back to the opinion that this is an interesting object that will demand further scrutiny. (Laughter.)

The President said the Society is often called upon to discuss supposed changes in nebulæ; but if observers did not agree in what they saw better than they had done in this case, the inferences drawn were founded on very treacherous grounds indeed. (Applause.)

Mr. Common read a note *On photographs of the nebula in Orion.*

The negatives, which were shown to the meeting, showed a large amount of detail in the central portion of the nebula.

Mr. Common said: I have made many attempts to draw the nebula, but it is a very difficult thing to get down on paper anything which is not of a definite shape. These photographs, however, could very well be enlarged, and by taking a series of photographs with longer and longer exposures, the fainter portions of the nebula could be brought out.

The negatives shown were taken with an exposure of ten minutes.

Mr. Knobel: I have examined these photographs, and think they are perfectly marvellous. I have studied the nebula of Orion in various ways, and consider that the amount of detail shown on these negatives, so far as it goes, is perfectly marvellous.

Mr. Common said he claimed no particular beauty for the photographs. They were taken more to try the effect of an electrical control to the clock than to get good photographs.

The President observed that if Mr. Common could produce photographs as much in advance of the present as the present were in advance of his former attempts, considerable light would be thrown upon the subject.

Mr. Common then read a note *On the illumination of micrometers.* The author said: There has always been some difficulty with regard to the illumination of micrometers. I formerly employed an oil-lamp, mounted as described by Mr. Burnham. I also tried incandescent platinum, as it could

be used in any position of the telescope and required no reflector, but found the platinum was easily destroyed by a slight increase of current. Vacuum tubes were also tried, but the experience of a shock in the eye was sufficient to make me give them up. Latterly I have used the small incandescent carbon lamps which are now sold and are made as small as five-candle power, and have found them answer admirably in every respect. A battery of five bichromate cells gives sufficient power, and the light can be varied by an arrangement worked by the foot for moving the plates in the solutions.

Mr. Marth read a paper entitled *Note on an apparatus for determining those errors of astronomical observations which are caused by the flexures of an instrument and by defects in the shape of its pivots.* The author said: At the December meeting, when a new form of transit circle was being discussed, I mentioned an old proposal of mine for determining flexures. M. Loewy has a communication on this in the number of the *Monthly Notices* which appeared yesterday. I will not allude to that paper except to touch on the point which is at the bottom of our difference of opinion. When a distant object is in the field of view of a refracting telescope, if the object-glass is shifted a little, what effect will it have upon the direction of that object? It is a question of ordinary geometrical optics, and any astronomer ought to be able to answer the question off-hand. I have always considered that the answer is: So long as an object-glass merely moves round the true optical centre, the direction in which the object appears is in no way altered. The optical centre is that point of the object-glass where all the straight lines cross which join the points of an infinitely distant object with the corresponding points of its image. I hope those who have studied the matter will correct me if I am wrong.

[The instrument was then exhibited to the meeting. It consisted of two object glasses, between which was a half-silvered reflector. When the apparatus was placed in its position, in the cube of the instrument to be examined, the wires of the eye-piece would be in the focus of one of the object glasses, and the object glass of the telescope in the focus of the other. A mark on the object glass of the telescope could then be seen directly through the unsilvered portion of the mirror, while the wires would be seen by reflection from the other half.]

Mr. Marth said: I have gone on the principle that the object glass might "wabble" about the optical axis and yet the direction of the line of vision would not be altered.

[Mr. Marth then illustrated his remarks by a drawing on the black-board.]

Mr. Christie asked several questions in explanation of the diagram, and then said: It is an extremely difficult question, and I do not rely myself upon any one method of determining flexure, because there are complicated strains entering into the matter. I think the methods I have seen described are highly artificial ones, and always seem to postulate a stability in the instrument, which is just the one thing you cannot be certain of. If you assume that there is a flexure between the eye-end and the object-end—which is known as astronomical flexure—that assumes that there is something going wrong with the instrument. Now, the cube is the weak part of the transit circle, and upon that point I should like to make a few remarks. It seems to me a question of great difficulty. I have been discussing it to a certain extent with Mr. Simms regarding the new transit circle which is being made for Melbourne. He quite agrees with me that this central cube is a mistake; though it was all very well in the olden time, when castings could not be made; and I propose somewhat of the old form of Troughton transit with a sphere instead of a cube. I had suggested that the telescope tube should be carried right through, but there are difficulties in doing this, as perforations have to be made for the illumination of the field of view, which would weaken the tube too much. Instead of that, he is going to make the central part an arched cylinder, bolting the two ends on. For determining the flexure, the best way, I think, is by reflection observations; it is the only method that I know of that appears satisfactory. It may be desirable also to interchange the object-glass and the eye-piece, or to determine the flexure by means of collimators, but then we have temperature as a possible source of error. I hope it will be understood that I am not throwing cold water on Mr. Marth's proposition. I think Mr. Marth's proposal a very good one; and I think M. Loewy's also good; but I think we ought not to rely implicitly upon any one method for determining this difficult correction of flexure. I should not rely only on the determination by collimators, nor upon the determination by reflection of stars; though I am inclined to trust to the latter more than to anything else at present.

The President: As far as I can understand it, this method of Mr. Marth's is an extremely valuable one as an additional test. There may be a certain amount of strain in the apparatus, but certainly it will not be anything like that of the ordinary flexure of the telescope. If you found that there was no correspondence between the flexures got from opposite collimators, then you would have stronger proof that you must get at the flexure by a method perfectly independent. With regard to determining flexure from

collimators, I am far more in favour of it than appears to be the case with Mr. Christie. Of course you are liable to uncertainties or dangers from changes of temperature. Still I don't see why with care the ill effects should not be eliminated, except through something in the room or in the air between the collimator and the telescope. Also, if you trust your determination entirely to your reflection observations, you lose a most valuable check on the existence of systematic errors in your instrument. There are undoubtedly in all our instruments far greater systematic errors than we are sometimes prepared to admit, and they can be only determined by different ways and by comparing agreements and disagreements. If you can determine your flexures by collimators, and supplement it by anything of the kind proposed by Mr. Marth, so as to give an additional check and then determine your nadir points independently, and then fall back upon reflection of stars, you get an amount of security that I don't know you can get in any other way. Therefore any idea of discarding the collimators is to be avoided. I know they are a little troublesome. I certainly look upon this as a good method of examining the flexure; but in the telescope that is proposed, and which I hope still to carry out, we shall have a better method than this, because I think we shall get rid of the flexure, and I think that is better than determining and correcting it.

Mr. Marth : You know that collimators are used merely for horizontal flexure. The point in this instrument is that it gives the flexure in any direction of the telescope. As regards reflex observations, you are confined to 40 degrees. I expressed my opinion on collimators and on exchange of object-glass and eye-piece in a paper twenty-two years ago, just because all those three methods did not give what was wanted. I have not pointed out how this instrument might be used with a prismatic telescope for determining flexure and pivot errors; but I have detained you too long already, and you will find it in the paper.

Mr. Christie : I agree with Mr. Stone that the greater the number of the different methods applied the better, but I differ as to the application of his principle. He assumes that we should rely upon the method of collimators, I think we should rely rather upon reflection observations. It is fair to assume that if you get your reflection observations to agree with your nadir determination you are all right; but supposing that you do not? I think it is found in the case of every observatory where they have reflection observations that the results do not agree, and are placed in difficulty. I am inclined to think on the whole reflection observations will give the most reliable results, because when we get observations in the different

parts of the circle we have a better chance of getting rid of systematic errors. With regard to Mr. Marth's objection to reflection observations because they are limited to 40 degrees from the zenith, that is a point which I have considered. Hitherto we have had no information on the law of the R.D. correction, but I hope soon to have an arrangement made by which the collimators may be moved out of the way, except when they are required, and then we shall be able to extend our reflection observations as far as 70 degrees of zenith distance; and I think that will be amply sufficient to give us the law of the R.D. correction. Whether that is the law of flexure or not I will not say; but it will, I think, be an important element in the discussion.

Mr. Marth: If you want to use the method you must reverse your instrument, because otherwise errors of division will always enter into your R-D. corrections, while, when you observe in both positions, and have everything symmetrical, you get rid of the error of division, because in the one position the same errors of division affect the flexure observations as the direct ones in the other.

Mr. Christie: But we must take things as we find them. The errors of division have been determined with great care. If we were to use other instruments we might possibly get better results which we could introduce into the correction for flexure, but the best has been done to determine the division errors, and I do not think that anyone who examines the determination will conclude that there is very much of an outstanding error—two or three-tenths of a second perhaps at the outside.

The President: I may mention that in two cases I have met with something that certainly was not flexure, but mixed itself up in the determinations of astronomical flexure arising from points connected really with the relative shift in the lenses of the object-glasses. The first one occurred at the Cape. I had difficulties with regard to the R.D. error, and it gave no end of trouble, and I found myself restricted to observing stars near the Pole because I was able to get rid of the error by referring directly to the Pole; but after a time it turned out that the greater part of these errors were due to the lenses having become loose in their cell. They were not properly put together, and there was a certain play of the object-glass lenses. They shifted slightly as the telescope was moved round, and that gave an appearance of flexure, and led to sensible error. The other case was in regard to the object-glass at the Radcliffe observatory. There was a large flexure, and the R.D. discordance was very considerable. I found there was a small play in the screw with which the object-glass was screwed on.

The screw was recut, and the flexure was at once cut down to more than a half of its amount, and the R.D. was cut down more than half also. So on our ordinary telescopes, when we are dealing with small quantities, there is, independently of flexure of tubes, something due to the shifting of the lenses of the object-glasses. Certainly the two difficulties I have named have come within my own experience.

Mr. Christie read a paper, *The Spectrum of Comet a* 1882 (*Wells*), observed at the Royal Observatory, Greenwich. It had been first examined on April 22, when a continuous spectrum only had been seen. On April 24, there were two ill-defined condensations in the green and greenish blue. On May 11 it was observed with the half-prism spectroscope, arranged to give purity of spectrum, but no bright bands were seen, nor any break of continuity in the continuous spectrum.

Mr. Howlett exhibited a number of drawings of sun-spots and called attention to the enormous dimensions of some of the spots that had been lately visible. Rapid changes had taken place in the form and character of some of the spots, and faculæ had been very numerous.

Mr. Christie: These spots to which Mr. Howlett has called attention have been photographed at Greenwich, and I have just been able to get some enlargements of them which probably may interest the Fellows. It is a very remarkable thing that there should be at the same time on the sun three spots visible to the naked eye. The larger of the three spots was more than two minutes in diameter, the other two spots were about a minute or rather more. The remarkable point about the spots is that soon after the first group appeared on the 13th April, there was, between the 16th and 17th April (civil reckoning), a great magnetic storm. Then there was a group preceding this large spot, which, though sufficiently visible, was not very conspicuous till the 17th April, when it burst out suddenly and there was a great outbreak, this group becoming nearly as large as the other group, which had appeared before. Then following this, on the 19th April, there was another magnetic storm that lasted about 28 hours. Both of these magnetic storms were very violent. It becomes an interesting question whether these magnetic storms were connected with the outbursts of sun-spots. In the first instance the spot appeared round the edge of the sun, coming into view on this side. The first magnetic storm occurred at the same time as the outbreak of the second spot. It is a question whether it was connected with the second spot, or whether the first spot coming round the limb of the sun exerted its influence on the magnetism of the earth some days after. It is only by noting

those cases and getting photographs that we can hope to solve the question of the connection which undoubtedlly exists between the earth's magnetism and the spots on the sun. A double outbreak on the sun and two magnetic storms are interesting facts to which I wish to draw attention specially.

Mr. Mattieu Williams: Were any remarkable prominences observed in connection with the magnetic storms? I ventured some time ago to suggest an explanation of this, that the prominences are the result of the re-action of the vortices, and that this ejection of vapour from the sun acts very nearly in the same way as the vapour in the Armstrong hydraulic machine; any such rush of vapour produces electrical disturbance, and consequently magnetic disturbance. If that be correct we should expect to find the magnetic storms after the spots. It will be remembered there was a remarkable magnetic storm observed at Kew many years ago, and at the same time another observer (Carrington) noticed, not a great spot in the sun, but a great flash in the face of the sun. In that case the great outbreak of light and the magnetic disturbance were simultaneous.

Mr. Maunder: I can quite confirm what Mr. Howlett has said about the large number of faculæ. The faculæ have developed in a very remarkable manner within recent months, and they stretch pretty nearly all round the sun, being traced at a much greater distance from the sun's limb than was the case a little while ago. With regard to the connection between the magnetic disturbances and the prominences during the few times I have lately examined the sun's limb the prominences have been but small, and searching in the neighbourhood of the great spot there were scarcely any prominences worth noting; so that in this particular instance it would seem that the magnetic activity was rather connected with the spots than the prominences.

Mr. Knobel read a note from Mr. Pratt on the great sun-spots of April, 1882, accompanied with photographs. The greatest spot was a rude square of 2′ 7″, or about 59,000 miles in diameter. On April 20, the great spot considerably altered in form, while a great development had taken place between two principal spots previously separated.

The President: We have here a paper by Colonel Tennant, discussing his observations of the transit of Venus at Roorkee in 1874. Colonel Tennant is under the impression that his observation of ingress is not considered so accurate as it should be. There is one curious point in the paper. Colonel Tennant is an exceedingly good observer, and is most firmly convinced that there is nothing like a black drop, or anything of the kind, but that what he saw was geometrical contact pure and simple; but the

curious point is, that in his paper he has made a large number of measurements of the distances between the limbs of Venus and the sun. He has proved that the apparent limb of the sun extended seven-tenths of a second beyond the limb at which the geometrical contact took place. I must confess that these statements appear to me to be absolutely incompatible. There could not have been geometrical contact if there were these seven-tenths of a second between the limbs; so that what Colonel Tennant calls geometrical contact is most probably what nearly everybody else has seen and called shadow or ligament between the limbs at the point of contact.

The following papers were also announced:—

J. B. Coit: *Determination of the orbit of ε Cassiopeiæ.*

J. Gledhill: *Observations of the phenomena of Jupiter's satellites made at Mr. Crossley's Observatory, Bermerside, Halifax.*

A. Graham: *Elements of the orbit of Comet Wells.*

THE TOTAL ECLIPSE OF THE SUN.

The Eclipse Expedition.

A telegram from Sohag, dated May 17, appeared in *The Times,* which reports: The total eclipse of the sun was successfully observed here to-day by the English, French, and Italian astronomers. A fine comet was discovered close to the sun, its position being determined by photographs. The spectroscopic and eye observations just before and during the period of totality gave most valuable results, the darkening of the lines observed by the French astronomers indicating a lunar atmosphere. A series of good photographs of the corona was obtained, and the spectrum of the corona for the first time was successfully photographed. The astronomers will probably leave on Saturday on board the Government steamer.

The Cairo correspondent of the *Daily News* telegraphs: "The weather being fine the eclipse of the sun was well observed here. It commenced rather before eight o'clock. The Arabs, who were very excited when the eclipse of the moon occurred, took no interest in the eclipse of the sun."

The following telegram has been received from Sir E. Malet, her Majesty's Agent and Consul-General at Cairo, dated May 18, 11.40 a.m., giving an account of the results obtained by the expedition to Egypt to observe the late eclipse of the sun.

Mr. Norman Lockyer asks me to send the following to her Majesty's Government:

"Unprecedented facilities were afforded by Egyptian Government for

the observation of the eclipse. A plan was agreed upon. The English, French, and Italian expeditions accord. Among results most satisfactory were photographs of the corona and its complete spectrum, obtained by Schuster and Abney's plates. H and K were the most intense lines. A study of the red end of the spectrum of corona and prominences by Tacchini. Comet near sun, striking object, photographed. With the naked eye bright lines observed before and after totality of different heights by Lockyer, and with intensities differing from Fraunhofer lines by Lockyer and Trepied. Absolute determination made of the place of coronal line at wave length, 1474 Kirchoff's scale, by Thollon and Trepied. Absence of dark lines in corona spectrum noted by Tacchini and Thollon with very different dispersions. Many bright lines in violet observed in spectrum of corona by Thollon and photographed by Schuster. Hydrogen and coronal lines studied in grating spectroscope by Puissieux, and with direct vision prism by Thollon. Rings were observed in grating by Lockyer. First, second, and third orders showed continuous spectrum, fainter than in 1878, stronger than in 1871. Intensification of absorption lines observed in group B, at moon's edge, by Trepied and Thollon."—*Daily Telegraph.*

SUN-SPOTS AND RAINFALL.

From *The Times of India*, April 22.

The sun-spot and rainfall theory has been superseded for the nonce by the sun-spot and magnetic disturbance theory, and if Miss Pogson's observations at Madras Observatory were of an exhaustive enough kind, we see no reason why the "sun-spot magnetic current and rainfall" question should not be considered one and indivisible. The main facts will be fresh in our readers' mind. [Follows a description of the large sun-spots and magnetic storms.] . . . These are signs in the heavens above from which useful prognostications or direful omens may be taken. "Isis," in the *Madras Mail*, on whose authority we quote the above figures, shakes our confidence in them a little, for we are also told that "the revival of solar and magnetic activity gives reasonable hopes of favourable seasons in this presidency for this and a few following years, a corresponding reverse being probably the fate of northern India." Now does "Isis" know this by intuition, or has she any reason for prophesying "reasonable hopes"?

REVIEWS.

The Bedfordian System of Astronomy, being New Theories of the Universe, explaining how sun, moon, stars, comets, &c., are formed, &c., &c., &c. By James Bedford, Ph.D. Third edition, with Appendix. Price one shilling. London: H. Vickers, 317, Strand, W.C. 1881.

We learn from this pamphlet that the sun is a solid igneous body, whose surface is very irregular; of which recent proof has been afforded

by solar eclipses, in which vast mountains rising above the general surface of the sun in an incandescent state, were distinctly seen, some of which were not less than 47,000 miles in height (p. 21). Sun-spots are volcanic eruptions (22). Our sun is still a "comet" to observers in distant systems, its "tail" (known by the name of the *Milky Way*) being in the direction in space last occupied by the solar orb in its progress towards the constellation Hercules (27). "Comets are infant worlds chemically progressing to habitable globes" (32). All planets were originally comets (34). Dr. Bedford is of opinion that immense quantities of gold will be found at the north pole, sufficient to pay the costs of the expedition proposed by Commander Cheyne, and all previous explorations, and an immense balance beyond (47). This is because the planets must move with the heaviest portion foremost, and that portion being with us, the north pole, the heaviest metals, including quantities of gold, will be found there (48). He suggests that in the revised edition of the Bible the fourteenth verse should take place of the fourth verse in the first chapter of Genesis, the fourth verse the place of the fifth, and so on to the fifteenth, the printer having made a mistake in the present arrangement of the chapter (52).

"The cosmogony, or creation of the world, has puzzled philosophers of all ages," says Mr. Jenkinson in the "Vicar of Wakefield," but the "Bedfordian System of Astronomy" was not known then. Its author being afraid that the "popular" cosmogony—the "nebular theory"—as well as all others extant, are most unsatisfactory, and that the attainment of truth is the desire of all philosophers, these theories of the universe are again submitted to the world, in full confidence that their teaching will bring consolation and peace to the homes of hundreds of thousands of terror-stricken families, who foolishly fear the immediate destruction of the world by the expected comet called "Pingré's Comet" (1857).

We wish such frightened persons more intelligible and solid grounds of comfort than are afforded in Dr. Bedford's speculations, well intended as no doubt they are.

The Sidereal Messenger. "The heavens declare the glory of God." Vol. I., March 1, 1882, No. 1, pp. 24.

The first number of this new astronomical periodical, edited by W. W. Payne, and published at Carleton College Observatory, Northfield, Minnesota, is very good. It contains a paper on comets by Prof. Boss, of Dudley Observatory, and much interesting matter besides. Carleton College Observatory was founded in 1878. With other instruments it has a Clark equatorial 8¼-in. aperture, and 10½-ft. focal length. and two clocks with electric and magnetic attachments. Extensive time service is performed. A list is given of the astronomical observatories in the United States, 45 in number, public and private, but the list is still incomplete. The terms of subscription to this promising journal per year (ten numbers, 24 pp.) are 2·00 dols.

---

1. *Gaseous Spectra in Vacuum Tubes, under small dispersion and at low electric temperature,* including an Appendix by Professor Alexander S. Herschel, M.A., Newcastle-on-Tyne. By Piazzi Smyth, F.R.S.E., Astronomer-Royal for Scotland. 2. *On the Constitution of the lines forming the Low-Temperature Spectrum of Oxygen.* By the same. From the Transactions of the Royal Society of Edinburgh. Printed for the Society by Neill and Company. 1881—1882.

Both these are interesting and valuable papers, as is also Appendix III.

by Prof. A. S. Herschel, on the magnificent features exhibited by end-on views of gas spectra under high dispersion. The following extract is remarkable: "With a new tube of nitrogen, in the hard glass, there is a minimum of hydrogen; and the bands, as well as the grouping of bands, proper to nitrogen throughout the red, orange, yellow, and citron, are the most delicate and beautiful series of gauzy veils, with sharp beginnings, imaginable, if viewed with a dispersion of 11° A to H, mag. power 10; and for this one powerful reason specially, that 'nothing interferes with them.' But in an old tube of nitrogen, though the same groupings of bands are seen beginning near the red hydrogen line, yet a little beyond that in the orange and yellow, the low-temperature lines of hydrogen come in like a thicket, and then no more nitrogen bands are identifiable, until we get beyond low-temperature hydrogen's chief manifestations of its progeny, viz., into the blue and violet. So far as these two just described tubes may be trusted, time and use with the spark would seem to have actually developed hydrogen in the older of them, either out of the glass matter of the tubes, or from the 'occluded' stores of gas in the polar wires, or more probably out of the nitrogen gas contents, and in that case, either by transforming nitrogen positively with hydrogen, or by disassociating it into its ultra-elements, of which the chief one must be hydrogen, and the other something not yet recognised. These two latter hypotheses are of course dead against chemical theory as it now stands, but agree remarkably with some very different and more elevated lines of both spectroscopic and chemical research, set forth a year ago by Mr. Norman Lockyer to the Royal Society, London.

"There would also appear to be an astronomical application which, if not fully made before by someone else, opens up now some most noteworthy views in the quasi-vital chronology of the stars of heaven itself. Thus our sun has been wasting for long geological as well as human-historic periods, in a temperature still higher than ordinary electric sparks; and what do we find there touching these two critical gases, nitrogen and hydrogen? That there is no nitrogen, but overwhelming hydrogen in the sun; or we might say, that its once supply of nitrogen has been long since converted by continued supernal electric heating into hydrogen. But in that case the beginning of the sun's luminous history was probably marked by nitrogen preponderating over hydrogen; and what do we find on recurring to Dr. Huggins' remarkable observation on these agglomerating materials for suns about to be, viz., the nebulæ? The answer is, 'one faint hydrogen, but a much stronger and double nitrogen, line.'"

Elements of Sidereal Astronomy. By Jacob Ennis. From the proceedings of the Academy of Natural Sciences, Philadelphia, for 1878. Philadelphia, 1878. pp. 7.

Mr. Ennis says, "Hitherto the work of astronomy has been mainly on our solar system. Beyond this the labour of astronomers has been given to individual stars, but not to these stars as a body forming our sidereal system. The time has now come when the sidereal system as a unit must be made in all its vastness a distinct object of investigation. I have demonstrated that our sun acts powerfully through gravity on the so-called fixed stars, and must receive powerful action in return." He specifies under thirteen heads how this investigation should be performed. Maps of different patches of stars all round the galaxy should be accurately made. "Hipparchus was the first to make a catalogue of a few hundred stars . . and he receives our sincere gratitude and homage. Who is to be the Hipparchus of the Milky Way, and to send down a blessing through all

generations to the end of time? What a worthy object for any young man to propose for the devotion of his life!" We fear Mr. Ennis is rather too sanguine. Prof. Grant ("History of Physical Astronomy") says, "It is impossible to avoid the conclusion that the path traced out by the sun is in reality curvilinear. . . It can hardly be doubted that the apex of solar motion is slowly shifting its position in the celestial sphere, and that it will eventually exhibit a sensible displacement. It is not improbable that, by this tracing out the path of the solar apex in the heavens, the actual path of the sun in absolute space may one day be determined. This would, indeed, be a magnificent triumph of inductive science, but a countless series of ages may, perhaps, elapse before its achievement will be realised." And referring to the very remarkable speculations of Mädler, about a central sun, he says, "It is manifest that all such speculations are far in advance of practical astronomy, and therefore they must be regarded as premature, however probable may be the suppositions on which they are based, or however skilfully they may be connected with the actual observations of astronomers."

The influence of the stars on the solar system was investigated by Laplace. It may interest some to know the conclusion reached. M. Ponticoulant ("Théorie Analytique," vol. iii., p. 325) says, "It would be necessary to assign to the stars a mass a hundred times greater than that of the sun in order that this term [expressing the perturbation of a planet in latitude] should amount to 10″ in a million of years. The same would hold good *a fortiori* in regard to the radius vector and the longitude; the influence of the stars on the movements of the planets may, therefore, for the present be considered as absolutely insensible," and he goes on to observe that whilst in reality there *is* an action of the stars on our system, yet by reason of the extreme distance of the former, the effects will probably be always inappreciable, and in any case will not be apparent except in very distant times.

THE CHRONODEIK.

In the *Science Observer*, vol. III., 27, No. 3, Boston, is a description with a cut, tables, and examples, of this little instrument invented by S. C. Chandler, Junr., for obtaining the time within a second by equal altitudes of the sun. It is 1¾-in. in diameter, about 9 inches high, of cylindrical form, compact and portable. Through a small telescope magnifying 7 or 8 diameters affixed to a swinging bar, the sun is viewed in a mirror at the bottom, and its passage observed over a wire so placed that it represents a section of a small circle in the heavens parallel to the horizon. The base is furnished with levelling screws. The price of the instrument is 15 dollars (about £3 3s.). Orders or enquiries may be addressed to Box 2,725, Boston, Mass. It seems to us well devised, and likely to be useful to amateurs, watch makers, surveyors, and travellers. It would be desirable, however, that an arrangement should be made for procuring it in this country. The drawback in our English climate is the uncertainty of obtaining an afternoon observation to correspond with the morning of the same day, or one in the morning to correspond with the afternoon of the day previous. We may add that the price of the *Science Observer* is 6 cents per copy, and 50 cents per volume; for European subscribers, 75 cents.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

A FIREBALL EPOCH.

Sir,—The nights of June 6 and 7 appear to require attention as a fireball epoch of considerable intensity.

On the morning of June 7, 1875, a brilliant meteor was seen at Melrose, in Scotland.

On June 6, 1878, a very brilliant fireball was seen by Mr. G. H. E. Trouvelot at Cambridge, Mass. It began near *o* Ursæ Majoris, and its apparent course was due west. On June 7 of the same year three large fireballs were observed from various stations in England, and two of them belonged to a radiant near the star Antares.

On June 7, 1879, a fireball, estimated to be as large as the full moon, was seen at Geneva. It gave a greenish light with iridescent colours, and its course was described as sinuous, presenting a strange zigzag form as it passed from N.E. to S.W. (?). A detonation was heard in the Valaisan Alps, and at Vittore Olona, Lombardy, a report like artillery followed its disappearance in about four minutes (*The Times*).

Other instances of large meteors and aërolitic fireballs will be found in the catalogues of different observers, as having occurred on June 6—7, and it is desirable that the sky should be watched at this special epoch for these phenomena. The great fireball of June 7, 1878, 9h. 52m., p.m., had a radiant at about R.A. 247°, Dec. 25° S. (near α Scorpii). This is close to the radiant of the great aërolitic meteor of June 17, 1873, seen in Austria and Bohemia, which was found by Dr. Galle and Prof. von Niessl to be at R.A. 248°, Dec. 20° S. If any meteors are seen this year on the nights of June 6 and 7, it will be important to note them carefully, and with especial regard to their apparent paths, brightness, and numbers.

Ashley Down, Bristol;
May 20, 1882.

W. F. DENNING.

LUNAR OBSERVATIONS—ATLAS.

Sir,—On the evening of April 22nd, I had a very satisfactory view of this interesting formation, the west wall of Fracastorius being on the terminator. With a power of 284 on an 8½-in. Calver mirror, the minutest details of the floor were brought out with remarkable distinctness. Among the most noteworthy objects observed were three rills. The first, η, shown in Neison's map, commences near the N.W. wall, and, after pursuing a slightly zigzag course, passes a little to the W. of the most S. of the central mountains and terminates near a break in the S.E. wall. Branching out from this rill, at a point near the S.E. wall, is a second cleft, which runs in a N. direction, nearly parallel to the apparent major axis of Atlas, and ends about half-way between the loftiest of the central mountains (the most N.) and the inner slope of the E. wall. It is far more delicate than η, its point of junction with which is marked by a dark spot which was suspected to be a crater. I can find no indications of this rill in any lunar map in my possession. The third object is situated on the N.E. portion of the floor, and consists of a cleft-like marking originating about mid-way between the central mountain just mentioned and the N. border. After proceeding for some distance in an E. direction, it bifurcates and turns towards the S., both branches dying out near the inner E. slope. This appears to answer in part to θ, described by Neison, but it is clearly forked, and seems to me to be as distinctly a rill as either of the former markings.

On the outer S.E. slope of Atlas I remarked an ill-defined dusky spot with a dark centre, from which proceeded two markings in a S.E. direction, the most S. is undoubtedly a ridge, but the other, which runs a little to the N. of it, appeared at times of best definition as a fine dark line, with all the character of a true rill.

The region between Atlas, Hercules, and Hercules A, is worthy of more careful study than it has hitherto received, no map showing accurately the remarkable configuration of ridges, &c., which are visible.

Bedford: May 1. Yours faithfully,

THOS. GWYN ELGER.

BRIGHT STREAKS ON THE MOON.

Sir,—In the *Astronomical Register* for March, 1882, p. 71, the Rev. Dr. Richards makes mention of some curious and interesting particulars relating to the bright streaks on the moon, and

desired information of similar or analogous appearances. The following particulars relating to these objects may be of interest as having some bearing upon the subject.

I have frequently remarked that when two or more streaks cross it is nearly always impossible to tell which streak lies uppermost; for if any particular streak is taken, it seems possible to trace it right through or over the other, as if it were uppermost, while if another streak be taken, exactly the same thing can be done, so that a strong impression arises that one streak is semi-transparent and allows of the other being seen or traced through it. In some comparatively few cases it is possible to see one streak traversing and completely concealing portions of another, such as the streak *a*, *o*, in Plato, which usually appears bright and sharply defined *on* streak κ, and the streak *p* in the same formation, which can be traced from spot 22 *over* streaks ϵ, ζ and the Sector. The same thing may be noticed in some of the rays from Copernicus, Kepler, &c., but these instances are comparatively rare.

A notable instance of this curious blending, or semi-transparent appearance of the streaks, occurs on the floor of Ptolemaeus, in one part of which nine streaks cross each other, or perhaps more correctly 18 streaks meet. At the point where these streaks meet is a large bright patch of light, but not by any means caused wholly by the junction of so many streaks, and it sometimes seems possible to trace any particular streak which may be picked out across the patch to a corresponding one, nearly opposite to it, and the same thing may be done with any other streak which may be chosen. This somewhat remarkable circumstance does not seem at all unnatural, for considering the circumstances of the probable nature and origin of the streaks, it is only what might be expected.

I have never yet seen any estimate of the probable number of spots and streaks on the visible surface of the moon, so perhaps the following may not be without interest. From a rough calculation, principally founded on the number of spots seen on the floor of Ptolemaeus, the number of craters seen by Schmidt on the same surface, and the number of craters said to be shown on his map, it appears that quite 100,000 spots would be visible in a 5-in. telescope. In the same way the number of streaks would amount to about 60,000. A 10-in. telescope would probably double the number. This estimate must only be considered as very rough, but it is probably within the real number.

West Brighton : Yours faithfully,
May 18, 1882. A. STANLEY WILLIAMS.

CANALS ON MARS.

Sir,—In your last issue (No. 233, p. 116) I find that my notes on the so-called "canals" of Mars do not lay sufficient stress upon the fact that in many cases the streaks in question seem to differ from both the neighbouring tones as regards depth and tint, though I have only been able to satisfy myself that this is true for the most conspicuous streaks (*e.g.*, the Lethe and Indus). As regards the more delicate markings of this class I strongly incline to the opinion expressed by Messrs. Green and Maunder, that they are rather boundaries of differently tinted districts than independent streaks.

I trust that 1884 may produce evidence obtained with a large aperture in a good atmosphere, which may go some way to decide the question by reason of the details referred to having been brought well within the limit of vision.

Loughlinstown, Co. Dublin: Faithfully yours,
May 19, 1882. C. E. BURTON.

LUNAR WORK FOR JUNE, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Mare Nectaris. Miss Ashley, of Bath, has been good enough to send me a note of an observation she made on Oct. 20, 1879, of the ring S.W. of *Theophilus*, to which I called attention last month (see p. 117). She only saw one of the two ridges there mentioned, but this one she had looked at frequently before she saw the ring at the western side of which it terminates. Schmidt's great map does not show the ring, though it gives a mass of detail, low ridges and craterlets, which perhaps are only visible in large telescopes. I should be glad to see drawings of this region by other observers.

In her letter Miss Ashley alludes to a paragraph in the *Selenographical Journal*, Vol. I., p. 24, to the following effect. In 1851 Schmidt, on observing the *M. Nectaris* under low illumination, saw two craters which were not given by Mädler or Lohrmann. The larger of these craters is in $+30°$ long. and $-14\frac{1}{2}°$ lat., and is over four miles in diameter. The smaller one lies about 12 miles to the north-east of it, and is two miles in diameter. Under high illumination they are seen as dark grey spots of triple their diameter. Klein thinks these objects could not have escaped Mädler and Lohrmann, had they existed in their time as craters—the larger one being as conspicuous as *Fracastorius E.* A very important observation was made by Schmidt in April, 1873, when he saw each of these two spots with a minute bright nucleus surrounded by a dark ring. They are well worthy of careful observation.

Mare Crisium. Miss Ashley has also kindly sent the following notes of observations of the two small craters on the ends of the promontories forming the eastern "pass."

1879, Sept.	2	Both craters visible and extremely distinct.
Sept.	3	Both visible.
1880, Feb.	14	Northern crater only visible.
Mar.	28	Both visible,

1880, April 15	Northern crater only visible.
April 26	Neither seen.
July 24	Southern crater only visible. Between the two points are two tiny hills (probably peaks on the wall of the northern crater?).
Sept. 19	Both visible, the northern the most distinct.

It is desirable to know on what conditions the visibility of these craters depends, and also to obtain as accurate a knowledge as possible of their relative size and position. Schmidt's map shows the northern crater exactly at the end of the promontory, and not less than two-thirds the size of *Picard E.*

For position we may form a quadrilateral figure by lines joining the northern crater, Picard E, Peirce, and the centre of Proclus. Of this four-sided figure (according to Schmidt's map) the northern side is parallel to the southern one, while the eastern and western sides are equal to each other.

MARE SERENITATIS. In a note on the crater *Bessel*, in the *Selenographical Journal*, Mr. Neison refers to the horned shadow observed by Birt and Newall, and described in *Lunar Work for April*, see page 94. The explanation of these horned shadows is by no means an easy matter, and it is specially recommended that observers should carefully examine the form of the shadow of *Bessel* on favourable opportunities. Such will occur on May 23, July 21, Sept. 18, and Nov. 16, for sunrise illumination, and on June 6, August 5, and Oct. 2 for sunset on *Bessel.*

WERNER. A spot on the S.E. side of this formation is very bright—another, on the inner slope of the N.E. wall, is stated to be as brilliant as *Aristarchus*, and more luminous than any other part of the moon. The Rev. T. W. Webb strongly suspects that this brilliancy has faded since the date of Beer and Mädler. In the latter spot Mr. Webb discovered a minute black pit and a very narrow ravine.

Neison in his "Moon" adds, that a very noticeable peculiarity in the brightness of the small spot on Werner is the *blueness* of its tint. He also adds the interesting fact that though Schröter measured and drew *Werner* and its region, examining it particularly on account of his believing the central peak to have formed since Cassini's time, he makes no mention of this glittering point, though it is seen now distinctly visible with an aperture of only two inches.

On page 94 of Vol. XIX. will be found a sufficiently copious list of objects with which the spot may be compared for brilliancy, and I should be pleased to receive notes of any observations.

St. Mary's, Bayswater:
May 19, 1882.

DISTRICT CATALOGUE OF WERNER.

WERNER is a ring plain, nearly circular, 45·05m. in diameter, its central peak being in —27° 45′ 42″ lat. and +2° 58′ 10″ long.

The origin of the measures is the central peak. The unit of distance is $\frac{1}{121}$ part of the moon's diameter.

Name.	*Objects.*	P.	D.
A	Crater-plain 6° bright, —27° 6′ lat., +0° 34′ long.	85	1·75
A 2	Craterlet adjoining *A* on the S.W.	90	1·5
b	Crater, N. of *A*	50	2·50
c	Craterlet on the N.W. wall	310	0·9
d	An irregular depression between *A* and *b*	60	1·6

A′	Central peak, 4572 feet high		
β	Peak on S.W. part of the wall	230	
γ	A mountain west of *Werner*	260	1·8
δ	Peak on N.E. part of the wall	40	
ε	Peak on S.E. part of the wall	150	
ζ	Bright spot on inner slope of the wall, close to δ		
η	Mountain mass south of *A* (the middle part)	100	2·0
λ	Peak on N.W. part of the wall	290	

DUN ECHT CIRCULAR, No. 51.

Elements and Ephemeris of Comet Wells.

The elements are computed from observations at Harvard College, 1882, March 19, the mean of three observations on April 15 at Dresden and Leipzig, and from the Kiel observation on May 12.

$$T = 1882,\ \text{June } 10{\cdot}56221 \text{ Berlin Mean Time.}$$

$$\left.\begin{aligned} \pi-\Omega &= 209^\circ\ 0'\ 31''{\cdot}2 \\ \Omega &= 204\ \ 54\ \ 54{\cdot}0 \\ i &= 73\ \ 47\ \ 29{\cdot}4 \end{aligned}\right\} \text{ Mean Equinox, } 1882{\cdot}0.$$

$$\log . q = 8{\cdot}783216$$

The representation of the middle observation is:

$$\Delta\lambda \cos\beta = +2''{\cdot}8; \qquad \Delta\beta = -1''{\cdot}8.$$

Ephemeris for Berlin Midnight: mean equinox 1882·0.

1882.	α h. m. s.	δ ° ′	log. Δ	log. r	Brightness.
May 22	3 16 23	+64 21·0	9·9497	9·8630	30·4
23	3 26 21	62 54·8			
24	3 35 17	61 19·1			
25	3 43 24	59 40·2			
26	3 50 43	57 58·2	9·9539	9·7896	41·8
27	3 57 21	56 13·3			
28	4 3 24	54 25·7			
29	4 8 54	52 35·2			
30	4 13 58	50 41·6	9·9634	9·6926	62·
31	4 18 36	48 45·0			
June 1	4 22 53	46 45·2			
2	4 26 53	44 41·3			
3	4 30 40	42 32·9	9·9792	9·5489	112·7
4	4 34 13	40 19·1			
5	4 37 36	37 58·2			
6	4 41 0	35 27·8			
7	4 44 36	32 44·3	0·0032	9·2780	351
8	4 48 46	29 40·2			
9	4 54 42	26 1·3			
10	5 6 37	21 38·7			
11	5 26 29	18 35·8	0·0145	8·9424	1564·7
12	5 45 32	17 20·2			
13	6 2 51	16 41·8			
14	6 19 4	16 18·1			
15	6 34 32	+16 0·8	9·9820	9·4335	189·3

The brightness on March 19 has been taken as unity.

Lord Crawford's Observatory, Dun Echt: 1882, May 19.

Dr. H. OPPENHEIM. Berlin, 1882, May 16.

LONGITUDE OF THE MOON'S TERMINATOR at MIDNIGHT.

N.B. — Means East. + West. M., Morning Terminator.
E., Evening Terminator.

1882.	° ′			° ′	
June 1	+83 8	E.	June 16	+79 48	M.
2	70 54		17	67 35	
3	58 41		18	55 21	
4	46 28		19	43 9	
5	34 14		20	30 56	
6	22 2		21	18 42	
7	9 48		22	6 27	
8	— 2 24	E.	23	— 5 44	M.
9	14 38		24	17 58	
10	26 52		25	30 12	
11	39 5		26	42 25	
12	51 18		27	54 39	
13	63 32		28	66 52	
14	75 45		29	79 4	
15	87 58		30	+88 42	E.

Moon nearest the earth ... June 6, 18h.
„ farthest from the earth „ 21, 16h.

THE PLANETS FOR JUNE.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	6 19 11	N.25 3	8″·0	1 39·5
	9th	6 43 56	N.23 18	9″·5	1 32·7
	17th	6 48 2	N.21 8½	11″·2	1 5·3
	25th	6 33 57	N.19 20½	12″·0	0 19·8
Venus ...	1st	6 27 58	N.24 41½	11″·2	1 48·2
	9th	7 10 23	N.24 4½	11″·5	1 59·1
	17th	7 51 59	N.22 43½	11″·9	2 9·1
	25th	8 32 21	N.20 42	12″·3	2 17·9
Mars ...	1st	9 4 24	N.18 16	6″·0	4 24·1
	8th	9 20 9	N.17 1	5″·8	4 12·4
	14th	9 33 39	N.15 52½	5″·6	4 2·3
Uranus ...	2nd	11 4 1	N. 6 49½	3″·8	6 19·6
	18th	11 5 1	N. 6 42½	3″·8	5 17·7

Mercury sets two hours after the sun at the beginning of the month the interval decreasing.

Venus sets two hours and ten minutes after the sun on the 1st, the interval slightly decreasing.

Mars sets a few minutes after midnight on the 1st, and then earlier each night.

ASTRONOMICAL OCCURRENCES FOR JUNE, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Antares.
Thur	1	8 33	○ Full Moon Sidereal Time at Mean Noon 4h. 39m. 28·22s.			— 11 40·8
Fri	2		Sun's Meridian Passage 2m. 18·6s. before Mean Noon			11 36·9
Sat	3	10 35	Occultation reappearance of 29 Sagittarii (6)			11 32·9
Sun	4	20	Uranus at quadrature with the Sun			11 29·0
Mon	5					11 25·1
Tues	6	11 55 12 56	Occultation of *c* Capricorni (4½) Reappearance of ditto			11 21·2
Wed	7	12 19	Occultation reappearance of κ Aquarii (5)			11 17·2
Thur	8	5 9 14 2 14 13 15 5	☾ Moon's Last Quarter Occultation of 15 Piscium (6½) Reappearance of ditto Near approach of 16 Piscium (6)			11 13·3
Fri	9					11 9·4
Sat	10					11 5·4
Sun	11					11 1·5
Mon	12	18	Conjunction of Moon and Saturn 2° 58′ S.			10 57·6
Tues	13		Saturn's Ring: Major axis=37″·46 Minor axis=14″·47			10 53·6
Wed	14	8	Conjunction of Moon and Jupiter 0° 37′ N.			10 49·7
Thur	15	6 33	● New Moon Illuminated portion of disc of Venus=0·865 Illuminated portion of disc of Mars=0·929			10 45·8

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Antares.
Fri	16	14	Conjunction of Moon and Mercury 1° 46′ N.			10 41·8
Sat	17	22	Conjunction of Moon and Venus 6° 18′ N.			10 37·9
Sun	18		Sidereal Time at Mean Noon 5h. 46m. 29·69s.			10 33·9
Mon	19		Sun's Meridian Passage 1m. 1·26s. after Mean Noon			10 30·0
Tues	20	6	Conjunction of Moon and Mars 6° 50′ N.			10 26·1
Wed	21					10 22·2
Thur	22					10 18·2
Fri	23	6 1	☽ Moon's First Quarter			10 14·3
Sat	24					10 10·4
Sun	25					10 6·4
Mon	26					10 2·5
Tues	27	18	Inferior conjunction of Mercury and Sun			9 58·6
Wed	28					9 54·7
Thur	29					9 50·7
Fri	30	18 8	○ Full Moon Near approach of B.A.C. 6347 (6½)			9 46·8
JULY Sat	1					9 42·8

Books received.—Bibliographie Générale de l'Astronomie. Par J. C. Houzeau et A. Lancaster. Tome second. Bruxelles: Xavier Havermans. 1882.—The Sidereal Messenger. Vol. I. Parts 2 and 3. Northfield, Minnesota. 1882.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To May, 1882.
Denning, W. F.
Ryves, E.W.

To June, 1882.
Lewis, H. K.

To Dec., 1882.
Herschel, Prof. A.
King, T. W. B.
Prince, C. L.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 235. JULY. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1882—83.

June 9th, 1882.

E. J. Stone, Esq., *President*, in the Chair.

Secretary—E. B. Knobel, Esq.

The minutes of the previous meeting were read and confirmed. Mr. Knobel announced that 51 presents had been received since the last meeting of the Society.

Franklen George Evans, Esq., Tynant House, near Cardiff,

was balloted for and duly elected a Fellow of the Society.

Mr. Knobel read a paper by Prof. E. C. Pickering *On a Meridian Photometer*, for photometric observations of stars on or near the meridian of not less than the 10th magnitude. The paper was accompanied with photographs. At the end of the instrument furthest from the eye-piece are two plane mirrors connected with tubes placed horizontally east and west, and capable of revolution in the plane of the meridian; their inclination to the axis of the tube may also be varied by connecting-rods and cords from the eye end. One of the mirrors is ordinarily directed to λ Ursæ Minoris, with which other stars are compared. The second mirror is connected with a tube projecting beyond the first, so that it may be directed to any star near its meridian passage. The light from the two mirrors is received respectively

by two object-glasses within the telescope of about four inches aperture. Both pencils of rays before reaching the eye-piece pass through a double-image prism, which can be reversed to eliminate the effect of polarization by the mirrors. The ordinary image from one mirror and object-glass is compared by means of a Nicol's prism with the extraordinary image from the other: the double-image prism is then reversed and the comparison repeated with the other pair of images. The two images are compared under exactly the same conditions, so that it is hoped that systematic error will be avoided.

Mr. Knobel also read a paper by Prof. H. Draper *On a photograph of the nebula in Orion*, of which photo-lithographic enlargements were laid before the Society. The negative was taken in the 11-inch refractor, with an exposure of 137 minutes, gelatino-bromide plates being employed. There was a wind blowing in gusts during the exposure, which caused the stars to appear slightly elliptical in the photograph. The larger stars are much over-exposed, two minutes being sufficient time for a good picture of the trapezium. In the original negative of this picture the separation of the stars of the trapezium can be seen in a good light, though in the photo-lithograph they appear as one mass. No single enlargement however can do justice to the negative. Most of the small stars, as well as the outlying streamers of the nebula, are represented on the photograph, which depicts stars almost the *minimum visibile* of the telescope. With a still longer exposure it may be possible to photograph stars invisible to the eye. A new form of mounting is contemplated, which will permit of an exposure of six hours. Photographs of the spectrum of the nebula with a slit spectroscope show two of the hydrogen lines in the ultra-violet, and traces of two others. Photographs taken without a slit show that two of the condensed masses preceding the trapezium give a continuous spectrum, and therefore contain either gas under pressure or liquid or solid matter.

Mr. Newall: I was speaking to Mr. Wesley on this subject yesterday, and he showed me the photograph and informed me that there was in the possession of the Royal Society, hid away and known to very few persons, a beautiful drawing by Mr. Lassell. I yesterday obtained the loan of that drawing from the Royal Society, and it is now on the wall here. I think it is the most perfect drawing of the nebula of Orion with which I am acquainted. I know the object pretty well, and it is one of the most extraordinary objects to be seen in the heavens. I should like to see Mr. Lassell's drawing reproduced. It could, I believe, be done at a small expense by photography, and would be well worthy of

distribution among the Fellows. (Hear, hear.) The drawing ought properly to have been presented to this Society. (Laughter.) In reference to Dr. Draper's photograph, it appears to me that the telescope must have moved very considerably to produce these nebulous masses about the three bright stars above the "fish-mouth" and those below. On examining the photograph it will be found that the stars, instead of being round, are oval in the east and west direction. The camera, I think, must have moved, and therefore we have not got so correct a representation as we might have had if the camera had been steady. There is a considerable difference between the photograph of Dr. Draper and the drawing of Mr. Lassell, as also between Mr. Lassell's drawing of 1862-3-4 (the Royal Society one) and that published in Vol. XXIII. of our *Memoirs* in 1852. One star, which in the drawing of 1852 is shown outside the "flame" (if I may use the term), is here shown inside. The drawing before us shows the six stars in trapezium, and a great many other small stars surrounding it.

Captain Abney: Looking at the photographs which we have before us, it strikes me that if Prof. Draper had taken the precaution of backing his plates with asphaltum, he would not have had this enormous increase in the diameter of the stars. This great defect is due to what we call "halation," and is caused by reflection of the scattered light from the back of the plate. The halation is more particularly to be found in the method that Dr. Draper used. It could be corrected by backing the plates with a solution of asphaltum in benzole. It dries very rapidly. For the Eclipse Expedition all the plates were backed with asphaltum, and had it not been so, I believe they would have shown a good deal of this halation, which is now absent.

Captain Noble: If this drawing of Mr. Lassell is to be reproduced, I hope an attempt will be made to reverse it and print it as the nebula is really seen in the heavens. It is puzzling to have the nebula represented as is done there, as it is difficult to compare it with the actual object. If a *positive* of that drawing were used as a *negative*, so as to print white on black, it would be more useful from a practical point of view. I mean simply the reversing of the colours—not that the diagram should be inverted.

Lord Rosse: With regard to using photography for that purpose, I may say that I had some drawings of Jupiter reproduced by photography, and they are far from satisfactory. The delicate markings in the pencil sketches do not come out as they should do. Nearly half of the impressions had to be rejected; and even the very best do not give the very delicate markings on the original drawing. Of course, you have the advantage of the thing being

accurately represented, so far as it is represented, and you have not the same trouble as with engraving or lithography; still, it is a great drawback not to have the fainter markings shown in full. I have always tried to have the features exaggerated in the drawings, so that when the photograph is taken they may come out about right. Many years ago, before the large drawing of the nebula in Orion was completed, it was thought desirable to circulate some drawings of the nebula among astronomers, and we found that with the old collodion process we got spots and markings which might be mistaken for faint nebulosity. Then we took the drawing to a man who was in the habit of copying oil paintings, and he did his best, but the result was not by any means equal to the original. I do not think any photographic process will exactly reproduce the fainter markings on a drawing. I believe the old process of copper-plate engraving is best, though lithography is a good deal cheaper. In regard to reversing the colour, I think there is a difficulty in getting white on black ground. There are drawings on the wall printed in white ink on a black ground, but the white does not come out very strongly. You cannot put the drawings in a portfolio, because the white rubs off.

Captain Abney: It is a practical impossibility to get an absolutely perfect photograph of a black and white subject. If you make the blacks very transparent, then the whites suffer; and if it is a half tint, the gradation is not the same between the two. The wet process is certainly the very worst you can adopt for the reproduction of delicate drawings such as that. The only chance of making what I may call a complete reproduction is to have the background slightly tinted, and then you will get a good gradation, which you cannot get from black and white. If you get a tinted background you can get the delicate half tints, because you have a smaller range of gradation to work up; but if you want a perfect white and black, the gradation must suffer.

The President: I think there is much more detail in Dr. Draper's photograph than in any other that I have seen: a good deal of faint nebulosity within the "fish mouth" is distinctly seen.

Mr. Maunder read a paper *On further spectroscopic observations of comet Wells, made at the Royal Observatory, Greenwich.* The most striking feature in the spectrum of this object has been the development of a bright line in the yellow, apparently corresponding with the D lines of sodium. It was measured on May 31st and again on June 7th, when the bright line had become of most extraordinary brilliancy, and so far outshone the continuous spectrum that the comet might almost be said to shine

by monochromatic light. Its telescopic appearance accorded with this, as it presented a planetary disc nearly as deep and vivid as that of Mars. Besides this remarkable bright line, several small irregularities in the spectrum were seen or supposed on different occasions.

A note on the same subject was also read from M. N. C. Dunér, of the Lund Observatory.

The President: I hardly know whether I ought to mention it, but I have received a letter from Dr. Copeland, saying that he has been examining this spectrum, and the D line is distinctly *double*. The character of the spectrum is pretty much that as described as the type of a certain class of stars with bright bands, only this has distinctly a double line D.

Mr. Hind: I should like to offer a few observations as to the possibility of distinguishing the comet in broad daylight to-morrow and Sunday. As far as I know, it has not quite kept pace with the theoretical law of increase in intensity of light, but I have not had the opportunity of watching it in the valley of the Thames. I take as a unit of reference the observation made by Mr. Knott, who has had great experience in the estimation of magnitudes in this country, on the 21st May—a star of the sixth magnitude, or a little over. Well, that being so, at noon to-morrow the comet will have the brightness of 100, which brings it up, under the ordinary law, to the brightness of a star of the first magnitude; and on Sunday it will have a brightness of 106. Now, the only comet that bears any comparison with this one, as far as I am aware of in modern times, is the first comet of 1847, discovered on the 6th February. On the 30th March I saw that comet with a 7-in. object-glass within $1^\circ\ 37'$ of the sun's limb, and got a fair observation of its position. The present comet will be distant from the sun's limb to-morrow at noon $3^\circ\ 3'$, and on Sunday $3^\circ\ 11'$. If the increase of light during the last few days is anything like that theoretically shown, I think those who have 8-in. apertures and upward will find it worth their while to look for it on the chance of seeing it. I should advise a long sunshade, which I found of advantage in 1847, but not too dark a sunglass. I may just mention that this comet will be visible again in this country at the beginning of July, and that we shall probably follow it till the middle of September, so that whether we get observations from the southern hemisphere or not, it will not very much matter for the determination of the orbit.

In reply to Mr. Penrose, Mr. Hind said: The maximum of light of the present comet in reference to the intensity when it was first visible to the naked eye, is 186, whereas the comet of

1847 had a ratio of 404. I do not think anything under a 7-in. telescope would bring it out.

Mr. Penrose: I tried for it at two o'clock to-day with a $5\frac{1}{4}$-in., and I thought I might see it, as the sky was very clear. There was a certain dazzle, but I think if it had been bright—as bright as Mercury—I should have seen it.

Mr. Knott read a note *On the variable star U Cephei*. The minima of this star occur in sets—alternate minima at intervals of about five days. The intermediate minima are observed when the next set comes round. I have a strong suspicion that there is a difference of about $\frac{3}{10}$ of a magnitude between the minimum magnitude reached in the two sets. If my suspicion should be confirmed by further observation, it would appear that we must regard the period as a double one.

In reply to Mr. Bidder, Mr. Knott explained that the magnitude was estimated by the system of limiting apertures. The curve showing the changes of magnitude was constructed from the complete series of observations.

Captain Noble: I would ask Mr. Knott, if these curves are thoroughly established, whether it does not throw serious doubt upon Professor Pickering's explanation of the variability of these stars, *i.e.*, that they are caused by some dark body revolving round the larger star, and alternately eclipsing it and leaving it free; because in order to produce an effect like this, the darker body would have to be able to expand and contract.

Mr. Knott: I look upon that as a kind of geometrical explanation of the phenomenon, but now that the knowledge of solar physics is enlarging, I should be sorry to express any opinion as to the causes for the variability of stars. If this is due to occultation, I think it must be an occultation by some nebulous body, because it changes in colour when it comes to the eighth magnitude, and then gets white again.

Mr. Penrose: What is the maximum magnitude?

Mr. Knott: About 7·2.

Mr. Christie: I think Captain Noble is under a misapprehension with regard to Pickering's hypothesis, because he has proposed several hypotheses, and he has broadly discriminated between stars like *Algol* and stars of the *β Lyræ* type. In stars like *Algol* he has explained the variation as due to occultation by satellites; but in regard to stars of the *β Lyræ* type he does not offer that explanation: therefore, if we are to regard this star as one of the latter type, the objection that Captain Noble urges to the hypothesis would not apply, because Pickering's hypothesis would be a different one. Of course it is put forward confessedly as an experimental hypothesis, merely to co-ordinate

phenomena which are known; therefore I do not think we can consider it as dismissed simply because we have one instance that does not accord with the special hypothesis. The essential point of Professor Pickering's investigations is to divide the variable stars into four or five different classes (I speak from memory), and for each one of these he has proposed a different hypothesis. Of course, as he has so many hypotheses, it is much more easy for him to reconcile them with the facts (laughter); but each one stands or falls alone. Take the case of *Algol* for instance: the test of his hypothesis rests on his being able to show that the increase or diminution of light agrees with that deduced from his law, as similarly in the case of β *Lyræ*. Then he considers also —though not to the same extent—the stars of long period and irregular period, which are much more difficult to deduce to laws. There are two principal hypotheses which he has considered. The one is the occultation by a satellite, or something of that nature; and the other, that of rotation upon an axis—different points of the body being supposed to present different degrees of illumination: either there may be spots on it, or obscurations of different kinds, which may, of course, be of elliptical shape; and from the discussions of these various hypotheses he deduces certain calculations, but he does not put them forward with any decided degree of confidence, except in the case of stars of the β *Lyræ* type.

The President: It appears to me these inequalities or variations are very desirable things to follow. Where you have got apparently two inequalities in the period, if they do arise from what you may call the satellite theory, you will, ultimately, by careful observation, be able to find out such changes in these variations as will enable you to determine the course. There are some cases in which there is apparently a considerable difference already recorded in the period of the variations; and if that period can be firmly established, we shall be able theoretically to work out the question whether it is due to the revolution of satellites, or from the disturbances taking place. Those who feel inclined to take up this subject, and carefully discuss the causes where there are apparently these two inequalities or variations, are likely to attain valuable results.

The President: As this is the last meeting of the session, I think to-night, perhaps, it will be agreeable to some of the Fellows if I were briefly to indicate the arrangements which have been made for the observation of the transit of Venus on the 6th of next December. So far as the British expeditions are concerned, no serious attempt is likely to be made to apply photography. When the committee was appointed, the time had really passed for making experiments, and no one appeared to be prepared to incur

the responsibility of urging on the Government the necessity of incurring the great expense required for attempting photographic observations. At the same time, we all felt that it was a matter of great regret that a number of hours during which the planet will be on the sun should pass without our being able to avail ourselves of the opportunity. But confining ourselves to the contacts, arrangements have been made which, with favourable weather, will justify us in expecting a fair determination of the sun's distance. It has been accepted generally by the committee that we have to recognise the existence of no inconsiderable errors in the observations of these contacts, therefore an attempt has been made to put as many telescopes in the field as possible with the amount of money placed at our disposal. It is arranged to send two parties to make observations at each station. We shall have two observers at the Bermudas, two at Jamaica, and two at Barbadoes. At the same time we are gratified to find that our efforts will be seconded by the Canadian Government. Quite recently the Canadian Government placed £1,000 at the disposal of the observers, who will work in harmony with our scheme. This will give us among the English expeditions, if we have favourable weather, 11 or 12 contacts for retarded ingress. This map represents the part of the earth turned towards the sun at ingress. Corresponding to West Indian and Canadian stations we have six telescopes in the Cape district. We shall have the good fortune, as in former years, of being assisted by the Cape observatory. One expedition with two observers will be sent to Madagascar. The colonists of Natal will have one telescope in the field. There will be another at the Mauritius, so that probably we shall have ten contacts for accelerated ingress. The effect of the parallax between these two sets of stations may be said to be roughly 11½ to 12 minutes, and consequently, unless our observers systematically go wrong at these opposed stations relatively to each other by certainly eight seconds of time, we ought to get the sun's distance within a million of miles; and if they do not go wrong relatively to each other by more than four seconds, we ought to get the distance within 500,000 miles. If attention is directed to the same kind of contacts, we ought most certainly to be able to get it within less than four seconds of time. With regard to egress, the same stations as for retarded ingress come in for accelerated egress. For retarded egress we shall have observers at Sydney and Melbourne. Two observers are going to New Zealand and two to Brisbane; and one gentleman, who wishes to join the party, will provide himself with instruments; so that we may expect to have ten or more of our own observers acting in concert in observing egress. At egress we

get rather larger intervals from the effects of parallax—perhaps 13 or 14 minutes—and therefore we should require a systematic error of 10 seconds of one set of observers relatively to the other set to give rise to an error in the distance of the sun of a million of miles. It is very improbable, however, that all our observers at one of these sets of stations should be relatively wrong with respect to the other observers by five seconds. Therefore I think five hundred thousand miles is a quantity we cannot leave untouched. But our own observers are not the only ones. There will be a large number of contacts observed on the American continent; and although it is greatly to be regretted that a large number of those observations will not have corresponding observations on the other side, so that their full value will not be realized, still they will be exceedingly valuable in themselves. There is one thing we have really to guard against: we must, if possible, avoid anything like a different kind of contact being observed by the American observers from that adopted by the English and other nations. If a different kind of contact is adopted, and any attempt is made to combine the American observations with our own and the Canadian, those at the Cape and Australian, it will lead to a different result from those obtained from our observations alone. As far as other nations are concerned there will also be a large number of contacts obtained. The French and German expeditions will be chiefly directed to the American continent. They are to have a large number of stations in South America, as well as a considerable number in the West India Islands. The Portuguese are sending an expedition to the West Coast of Africa, and of course have their own observatory at Lisbon. The Spaniards are also sending to the West India Islands. All these observations will be of great value if made on the same system. If stations are only adopted where the effects of parallax are very large, any error which may be made is thrown upon the determination of parallax, but there may be an error in the semi-diameter or the parallax. The indications given by different observations of ingress and egress at intermediate stations where the factor of parallax is not very great, shows that something has gone wrong. These intermediate stations therefore are exceedingly valuable in separating the effects of the semi-diameter and the parallax. Perhaps the most gratifying thing of the whole is the alacrity with which our brethren in the Colonies are coming forward in the matter. (Hear, hear.) They have granted considerable sums of money, and appear to take pride in being able to do something to assist the old country in carrying out a great scientific expedition.

Mr. Hind: I feel confident that you have been gratified with the authoritative information as to the proposed observations of this important phenomenon. No one who has had the opportunity, as I have, of serving on the committee of the Royal Society with reference to this phenomenon, can be ignorant of the immense amount of care and attention which Mr. Stone has bestowed upon the arrangements. If success attends the British expeditions it will be in a great measure owing to the care which our President has taken to bring about that result. (Hear, hear.)

Mr. Knobel read a paper by the Rev. S. J. Perry *On spectroscopic observations of the solar eclipse of May* 16, 1882, in which the author quoted from observations made at Lyons by M. André relative to the phenomenon of the black drop, which could be seen on the occasion of the occulation of a solar spot by the moon during a solar eclipse.

The following papers were also announced and partly read:—

S. W. Burnham: *Measures of the companion to Sirius.*

S. W. Burnham: *Double-star observations made in* 1879 *and* 1880 *with the* 18½*-inch refractor of the Dearborn Observatory.*

Dr. F. Terby: *Remarques à propos des récentes observations de M. Schiaparelli sur la planète Mars.*

Prof. O. W. Pritchett: *Transits of the red spot across the apparent central meridian of Jupiter.*

T. W. Backhouse: *Observations of comet b,* 1881.

C. E. Burton: *On the possible existence of perturbations in cometic orbits during the formation of nuclear jets, with suggestions for their detection.*

C. E. Burton: *Note on lunar photographs taken after enlargement of the primary image by an eye-piece.*

Capt. J. Parsons: *Sextant observations of comet b,* 1881.

E. J. Stone: *Some remarks on Prof. Newcomb's paper "On the instructions for observing the transit of Venus formulated by the Paris International Conference."*

A. Marth: *Note on M. Loewy's communication referring to an apparatus for determining flexure errors, with some remarks on Prof. Houzeau's (and M. Schäberle's) proposal on the same subject.*

A. Marth: *Note on the best method for determining the errors of circles and scales.*

A. Marth: *Ephemeris for physical observations of Jupiter.*

E. J. Stone: *Curves showing the changes in the diameter of the moon from the Greenwich observations,* 1750 *to* 1830.

F. C. Penrose: *Elements of the orbit of comet Wells, obtained graphically.*

THE ROYAL OBSERVATORY, GREENWICH.*

The meeting of the Board of Visitors took place on June the 3rd. Sir George B. Airy retired from the office he had held with so much distinction on August 15, 1881, so that a portion of the observations in this report were made under his superintendence. This, the first report of his successor, gives good hope for the future. No essential alteration in the long-continued course of observation has been made, but Mr. Christie shows that the omission of unnecessary figures in the reductions, and a certain restriction of the altazimuth observations of the moon would materially economise the force disposable, and enable the Observatory to meet the frequent demands of the scientific public for equatorial observations of a miscellaneous character.

As things stand, it is evident that the resources of our national Observatory are over-taxed. Changes consequent on the retirement of Sir George B. Airy caused a pressure of work, which through the zeal of the members of the staff was adequately met. The actual constitution of the staff is as follows: Mr. Dunkin, chief assistant, has the general superintendence of all the departments of the Observatory, with full power to act during the absence of the Astronomer-Royal. Mr. Ellis, Mr. Criswick and Mr. Downing are first-class assistants; Mr. Criswick superintends the astronomical computers, and with the assistance of three or four computers, takes charge of the transit reductions, and miscellaneous computations; Mr. Downing, assisted by one computer, has the charge of the altazimuth reductions; Mr. Ellis, as superintendent, and Mr. Nash, as assistant, have charge of the magnetical and meteorological department, and have three or four computers to assist them. Mr. Maunder, Mr. Thackeray, Mr. Lewis, and Mr. Hollis are second-class assistants. Mr. Maunder is charged with the spectroscopic and photographic reductions, in which he has the aid of one or two computers. Mr. Thackeray is principally employed on the library and manuscripts, and has also charge of the chronograph and of the stationery. Mr. Lewis, with one computer under him, has the charge of the time department and of the money accounts. Mr. Hollis undertakes the circle reductions, with the assistance of one computer. We now extract a few particulars that may interest our readers.

The new library building is now ready. Under the head of spectroscopic and photographic observations we find that a solar

* *Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich.* Read at the Annual Visitation of the Royal Observatory, 1882, June 3.

prominence on May 13, 1882, was observed to rise through a space of 30″ in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement . . corresponding to a motion of recession, increasing in two minutes from 36 to 330 miles a second. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on 1880, November 27, have been generally observed to be present in the spectra of spots during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum. The total number of stars of which the motions have been spectroscopically determined is now 106. A comparison of the successive determinations of the motion of Sirius indicates a progressive diminution from about 22 miles a second in 1877 and 1878 to about seven miles a second or less this year, and as other stars do not show anything similar, it appears likely that the change is due to the orbital motion of Sirius. Further observatious will, however, be required to settle the point. 332 photographs of the sun have been selected for preservation. There were only two days out of 200 on which the sun's disc was observed to be free from spots. There has been a large increase in the number and size of spots and faculæ, the mean of the daily areas for each in 1881 being nearly double of the corresponding quantities for 1880, and the increase is still continuing, though with well-marked fluctuations. A very remarkable outbreak of spots occurred in April last.

The following are the principal results for magnetic elements for 1881: approximate mean western declination, 18° 27′; mean horizontal force, 3·915 (in English units), 1·805 (in metric units); mean dip, 67° 35′. Magnetic storms occurred September 12 and 13, and April 16 and 19. Those of April were of more marked character than any that had taken place since the great storms of 1872, and it is a significant fact that exceptionally large spots made their appearance on the sun shortly before, viz., on April 11 and 17. Smaller magnetic movements are now also much more frequent. In regard to the long period variation of about 11 years, we are able now to say definitely that the minimum as regards diurnal change of declination occurred at the commencement of 1879, whilst as regards diurnal range of horizontal force, it occurred unmistakably earlier, about August, 1878.

From the meteorological observations we find that the mean temperature of the year 1881 was 48°·7, being 0°·6 lower than the average of the preceding 40 years. The highest air temperature was 97°·1, on July 15, and the lowest, 12°·7, on January 17.

The mean daily motion of the air in 1881 was 291 miles, being 12 miles greater than the average. The greatest daily motion was 999 miles, on October 14, the day of the great storm, and the least 59 miles, on May 25. A velocity of 61 miles an hour was recorded on October 14, and one of 58 miles an hour on April 29, these being both greater than any recorded in previous years. The greatest pressure was 53 lbs. on the square foot, on October 14. On April 29 a pressure of 49½ lbs. was recorded at a time when the hourly velocity was 50 miles. The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1881 was 1,301, which is more than 100 hours above the average of the four preceding years.

Under the head of chronometers and time signals, we learn that the number of chronometers now tested at the Observatory is 214, 168 of which belong to the Government, the remaining 46 are undergoing the annual competitive trial, and of these 18 are fitted with Airy's supplementary compensation. Besides the above, six chronometers have been placed on trial for the Mauritius Observatory, and five have been tested for the Japanese Government. Notwithstanding that the competitive trial of 1881 was more severe than usual, on account of the greater range of temperature, the first six chronometers performed on the average slightly better than those in any year since 1877, and the first chronometer was exceptionally good. The improvement shown was probably to some extent due to the prizes offered by the Clockmakers' Company, for the first time last year, for the first two chronometers. The Westminster clock has continued to perform well, its errors having been under one second on 40 per cent. of the days of observation, between one second and two seconds on 44 per cent., between two seconds and three seconds on 14 per cent., and between three seconds and four seconds on two per cent.

We are informed that the printing is going on very satisfactorily, and it is hoped that the volume for 1881 may be passed for press by the end of this year.

REVIEWS.

Bibliographie Générale de l'Astronomie, ou Catalogue méthodique des Ouvrages, des Mémoires et des Observations astronomiques publiés depuis l'origine de l'Imprimerie jusqu'en 1880. Par J. C. Houzeau, Directeur de l'Observatoire Royal de Bruxelles, et A. Lancaster, Bibliothécaire de cet établissement. Tome Second : Mémoires et Notices insérés dans les Collections Académiques et les Revues. Bruxelles : Imprimerie Xavier Havermans, Galerie du Commerce, 24 à 32. 1882.

The second volume of this unique work is now complete. It forms a volume of 2,225 columns, two to a page. We have before adverted to it

as designed to be a repertory of all astronomical labours in print up to the present time. The first volume is devoted to separate publications, the second to memoirs, notices, and journals, the third to observations and observatories. The publication is begun with the second, as it appeared a more pressing desideratum. In its preparation abstracts were made of 25,000 articles, contained in more than 25,705 volumes; the titles of the articles are given in the languages in which they were written. The Introduction (pp. lxxxix.) explains the plan of the work, and everything required to make it easy for reference. There is a classified index of subjects under the different headings which relate to articles. 1. On the history and study of astronomy. 2. Biographies of astronomers. 3. Spherical astronomy. 4. Theoretical astronomy. 5. Celestial mechanics. 6. Physical astronomy. 7. Practical astronomy. 8. Monographs of the principal bodies of the solar system. 9. Stellar astronomy. There is also an alphabetical table of subjects, and an alphabetical list of the authors whose writings are referred to in the volume.

The preparation of this work has furnished some interesting statistics relative to science. Reviews and the transactions of learned societies belong for the most part to the last two centuries, and are written almost entirely in modern languages, Latin being used only in the 1-15th part. It is otherwise with regard to separate publications. Amongst the modern tongues there are two of nearly equal importance, the French and the English. These together constitute about two-thirds of the matter of the collections. The German comes next, after which there is a long leap, all the other languages having but a secondary importance. At the head of these stands the Italian; and taking account of the relative numbers of the populations, it may be added that the Spanish and the Polish are at the bottom of the scale. The figures in the table for the first four are: French, 5,991; English, 5,809; German, 4,438; Italian, 791. Spanish is 29, and Polish 7. Scientific activity, the authors observe, seems but little affected by political events. This holds good especially when they concern only one or two countries at a time. The most disastrous wars of the eighteenth century are not decidedly marked in our table, and the great French revolution itself is barely indicated by a sensible fall in 1794. On the other hand, the long wars of the first French Empire, which brought ruin to the greater part of Europe, decidedly retarded the general advance. The year 1815 fell so low that to find one so barren we must go back nearly half a century. But no sooner is the crisis over than the intellectual growth is renewed, and an era of fertility set in such as never had been attained before. It was the time when the Astronomical Society of London was founded. . . . Properly speaking it was only from the year 1665, the date of the foundation of the Royal Society, and the appearance in Paris of the *Journal des Savants*, that the literature of the collections commences. MM. Houzeau and Lancaster have made a table and constructed a curve from it to exhibit the rate of progress. We see the curve creeping near the bottom from 1660 to about 1720, rising to the first division between 1760 and 1770, then more rapidly to the second division about 1800. It wavers between 1800 and 1835, reaching the third division between 1820 and 1835, from which last date the rise is rapid in the extreme, reaching the 16th division between 1870 and 1880, when the curve looks as if it were asymptotic to the next ordinate, as though indicating an indefinitely great and rapid progress in the future!

On this accelerated production of writings, which almost makes it impossible to keep up with the march of a science, or even to follow the progress of a special and restricted branch, the authors remark that

bibliographical bulletins are over-loaded, and that division becomes increasingly a necessity. "Each science, each branch, should have its separate bulletin. The oft reappearance, at intervals of twenty or twenty-five years, of the same speculative ideas, already published, discussed, and often rightly condemned after due examination by one or other of the generations that have preceded us, is owing to ignorance of what has been already done. The sole means of preserving science in all its vigour is to clear it carefully and constantly from all that is dead. Branches that are new and need sap are too many to allow of the strength of workers being brought to bear otherwise than as a historic study on the illusions of the past."

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

THE METEORIC EPOCH JULY 25—31.

Sir,—The period July 25—31 is a notable meteoric epoch, not only on account of the frequency of meteors, but also because of the large number of different showers in activity. This year will not be favourable for the re-observation of these particular streams, as moonlight interferes, but the following summary of the principal showers may be useful to those who may undertake their future investigation.

Ref. No.	Date.	Radiant Point. α °	δ °	No. of Meteors.	Observer.	Notes.
1	July 25—31	6	+37	18	D. 1878.	Meteors very swift, with streaks. Seen by T. July 27, 7°+32°.
2	July 21—Aug. 1	12 11	+52 +47	26	D. 1878	S. and Z. give: July 21 0°+55; 31 3+49; Aug. 1 10+56
	July 25—31	13	+53	18	H. W. Z. & K.	
3	July 31—Aug. 1	12	+70	16	D. 1878	Confirmed by Heis. Meteors swift and short without streaks.
	July 25—31 and Aug. 13	15	+70	35	H. W. Z. & K.	

Ref. No.	Date.	Radiant Point. α δ ° °	No. of Meteors.	Observer.	Notes.
4	July 26—Aug. 1	28 + 36	12	D. 1878	S. & Z., July 30, 32° + 35°
5	July 21—31	32 + 53	63	D. 1878	A very fine shower of streak-leaving meteors, from slightly S. of χ Persei.
	July 25—31 and Aug. 13	32 + 51	35	H. W. Z. & K.	
6	July 31—Aug. 1	291 + 70	14	D. 1878	Heis B_5 Aug. 3—19. 292° + 70° 226 meteors.
7	July 25—31	324 − 9	16	D. and others	1873—81. A radiant of fire-balls. = T. 44, July 28, 326° —13°.
8	July 31—Aug. 1	332 + 50	14	D. 1878	*Lacertids.* Heis B_4, July 22—Aug. 28, 326° + 54°. 502 meteors.
9	July 25—26	332 + 37	11	D. 1878	Meteors slow, very bright.
	July 27—31	332 + 27	7	D. 1878	Meteors swift and faint. Showers were seen by Heis and S. and Z. at 336° + 30°, July 24—31.
10	July 27—31	341—13	54	D. 1878	Meteors slow, long flights. Fine shower seen by T. at 340°—14° July 27—Aug. 1.

These radiants are amongst the most prominent at this epoch, though they form a very small minority of the aggregate number which may be observed. Nos. 5 and 10 in the table are of very special character, on account of their intensity. No. 5 is probably allied to the August Perseids, and formed by a few early members of that well-known display.

This meteor epoch merits close attention on account of the

large number of fireballs which it furnishes, and which evidently belong chiefly to the showers of Perseids and Aquariads above referred to. The radiant in Andromeda at $6° + 37°$ also supplies some fine streak-leaving meteors at this time, and there is a well-defined shower of fireballs from the region of Aquila (at $303° + 12°$) which severally increase the unusual number of meteoric phenomena observed at this season. A further series of prolonged watches during the last seven nights of July will be sure to give important materials as to the relative positions and intensities of the different showers, and as to their peculiarities of speed and brightness. It will be useful to determine whether the radiant near χ Persei really represents the on-coming of the Perseids of August 10. My own observations during the last five years appear to show most conclusively that the radiant point of this shower advances with the time; for while on the last few nights of July it is closely S. of χ Perseus, it has progressed by August 10 to a point at $44°{\cdot}7 + 56°{\cdot}7$. The observations on successive nights show this displacement to be gradual, as it is sharply defined, though it may well elude detection unless the observations are very close and persistent, owing to the very large number of minor radiants outlying the position of the main stream.

Bristol: June 1, 1882. W. F. DENNING.

The abbreviations in the table are: T., Tupman; S. and Z., Schiaparelli and Zezioli; D., Denning; H., W., Z., and K., radiant points derived from the catalogues of Heis, Weiss, Zezioli, and Konkoly, for which see *Monthly Notices* of the R. A. S., Vol. XXXIX., pp. 22—31.

THE MARE CRISIUM.

Sir,—In "Celestial Objects," p. 89, occurs the following passage with regard to this Mare:—"On rare occasions it has been seen by Schr., and in part by B. and M., speckled with minute dots and streaks of light. Something of this kind I saw with a fluid achromatic, 1832, July 4, near I. quarter. A similar appearance was noticed by Slack and Ingall, 1865. It would be difficult to say why, if these are permanent, they are so seldom visible; a suggestive though at present unintelligible phenomenon." In this quotation attention seems to be particularly drawn to the rarity of this feature. But is it so rare? The Mare always appears to me more or less covered with light specks and streaks. Nor do the more striking occasions, when these objects appear unusually numerous, bright, and well-defined, seem to be so very

uncommon. Perhaps I may be permitted to make the following extracts from my note-book in illustration of this:—

"1881, May 9.—9h. 30m., $5\frac{1}{4}$-in. Calver, power 150. Definition fairly good. This Mare seems covered with a close network of innumerable streaks, and spotted with countless numbers of light specks, so that it would hardly be possible to delineate them all in one night. The spots and streaks together must number 1,000 nearly. I have never seen anything like the number of spots and streaks . . . . Peirce A. is not at all easy, and neighbouring spots almost as bright make it difficult to distinguish which is Peirce A."

"1882, March 26.—8h. 9m., 2·75-in. achrom., power 75. Definition good, but too much wind to use the $5\frac{1}{4}$-in. The Mare is one mass of light streaks and spots; not that this is unusual, but they are so unusually plain, distinct, and bright, especially the streaks. I cannot recollect seeing the streaks so bright and clear with this instrument before, and hardly, if ever, with the $5\frac{1}{4}$-in."

The Mare Crisium has been examined for a few minutes on nearly every fine night during the past six or seven months, from which it appears that in every two or three lunations, if not oftener, there will probably be one of these unusual exhibitions. In the present state of Selenography and Selenology it is difficult to tell exactly how much of this depends upon the state of the earth's atmosphere, but probably more is due to this cause than is usually supposed.

West Brighton:
June 15, 1882.

Yours faithfully,
A. STANLEY WILLIAMS.

P.S.—The following may be of use to the Rev. Dr. Richards. On May 4th, 1882, at 12h. 12m., the two small craters on the ends of the promontories forming the "pass" on the east of the Mare Crisium were about equally plain. The one on the southern promontory was thought to be a shade larger than the other.

BRIGHT WHITE METEOR.

Sir,—A brilliant meteor witnessed by me from Bournemouth on the evening of the 7th deserves recording. The time was 9h. 45m., colour silvery white, exceeding Venus in brilliance. momentary train. Course, as nearly as could be described considering the twilight, from 5° above Castor nearly to a point 10° below Mars. Duration exactly 10 seconds, finally bursting into two meteors.

Melplash Vicarage,
Bridport: June 19.

Faithfully yours,
S. J. JOHNSON.

HYGINUS N.

My dear Sir,—The following observation may possibly be of interest.

April 25th, 1882, 8h. 25m., G.M.T. Hyginus N was seen as a shallow depression (apparently), the preceding edge of the dark spot being its darkest part, as if the crescentic shadow of a low bank or wall fell there. At the following edge was a narrow stripe, brighter than the general tint of *n*, presumably the illuminated inner slope of the same bank or circumvallation, if that which presented no indication of an internal slope can rightly be so designated. Power 270 on a 9-in. Newtonian.

Loughlinstown, Co. Dublin: Faithfully yours,
1882, June 19. C. E. BURTON.

LUNAR WORK FOR JULY, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

East of *Delisle*, at the distance of about two of the adopted units, is a singular triangular formation, which is very imperfectly figured in the maps. Neison calls it "a small triangular plateau, on which rises the peak *a*"; in a letter dated Nov. 8, 1868, Mr. Birmingham speaks of it as "a curious formation, such as would have delighted Gruithuisen. It appeared as a group of three hills in a slightly acute-angled triangle, and connected by three lower embankments." It is well worthy of attention and careful drawing, as no good delineation of it seems to exist.

Mare Crisium. In the *English Mechanic* of June 16 is a letter in which Mr. J. G. Jackson, of Hockessin, Del., U.S.A., states that he saw a *mist* lying over the western edge of the Mare, "just on or immediately within the dark of the terminator." From his letter I conclude that Mr. Jackson has only recently commenced to observe the moon, and it would be interesting to know if any more experienced selenographer happened to observe the neighbourhood of the Mare Crisium on May the 19th, the date of Mr. Jackson's observation.

Fracastorius. The neighbourhood of this formation is perhaps one of the best studied in the moon, but no complete and detailed lescription of its craterology has as yet appeared. The District Catalogue now given includes all the objects which have been observed and described by at least two observers, and which have therefore been registered and named as certainly existing. I should be much obliged for any additional information which will enable me to extend the Catalogue, and especially for alignments which will fix the positions of the objects.

St. Mary's, Bayswater:
June 17, 1882.

District Catalogue of Fracastorius.

Origin of measures, the peak δ.
Unit of distance is $\frac{1}{121}$ of the moon's diameter.

Name.	*Objects.*	P.	D.
Fracastorius.	A circular walled plain (of which the north part of the wall is destroyed), lat. —20°, long. +33°.		
A	Ring plain (walls 5°, interior 3°)	205	4·5
A 2	Craterlet on W. wall of *A*		
A 4	Craterlet W. of *A*2, on W. wall of *A*		
B	Ring plain (walls 5°, interior 3°)	230	3·5
B 2	Craterlet adjoining *B* on the W.		
c	Ring plain	190	4·3
d	Rounded valley just outside the E. wall	140	3·5
d 2	Craterlet within *d* on the S.		
E	Deep crater (walls 7°, interior 6°)	310	3·0
E 2	Craterlet S.W. of *E*		
E 4	Craterlet S. of *E*		
E 6	Craterlet S.E. of *E*		
e	Crater on the N. end of E. wall	90	0·1
f	Small crater on the floor	230	1·5
H	Crater W. of Fracastorius	260	3·5
K	Shallow crater or depression on N. boundary	300	1·0
m	Craterlet on east part of the floor		
n	Craterlet on the floor, W. of *m*		
p	Craterlet on S. part of floor		
q	Craterlet, aligning *p*, *q*, *m*		
r			
s	Craterlet on S.W. part of floor		
u	Craterlet on W. part of the floor		
v	Craterlet on E. part of floor, N. of *m*		
w	Craterlet on S. wall	185	2·6
x	Craterlet just east of *w*, on S. wall	182	2·6
z			
α	Peak on the E. wall (8511 ft.)		
β	Peak on E. wall, N. of α (7431 ft.)		
γ	Peak N. of β (5199 ft.)		
δ	Peak at N. end of E. wall		
ε	Mountain arm from *d* to *Beaumont* c		
Z	Mountain peak N.E. of *c*	190	4·0
ζ	Mountain S.E. of *Fracastorius*	160	4·0
θ	Rill between *b* and *Fracastorius*		
ι	Mountain arm between *A* and *Fracastorius*		
κ	V-shaped mountain on the N. part of floor	260	1·5
λ	Peak on W. wall		
μ	Narrow crested ridge connecting *K* and δ		
μ 2	Craterlet adjoining μ on the E.		
ξ	Rill inside E. wall		
φ	Curved rill on S. part of floor		
ψ	Delicate rill just inside W. wall		
ω	Peak at N. end of W. wall		
ω 2	Craterlet adjoining ω on the W.		

COMET 1882*a* (Wells, March 17).

The following ephemeris of this comet appeared in *Nature*, June 15th :

At Greenwich Midnight.

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth.	Log. distance from Sun.
July 1	9 35 98	+11 57·0	0·0501	9·8925
3	9 50 49	11 23·2	0·0673	9·9205
5	10 4 21	10 50·2	0·0850	9·9461
7	10 16 43	10 18·2	0·1027	9·9697
9	10 28 2	9 47·4	0·1202	9·9916
11	10 38 26	9 17·9	0·1375	0·0120
13	10 48 1	8 49·6	0·1545	0·0310
15	10 56 54	+ 8 22·4	0·1711	0·0489

On July 1, the comet sets 1h. 44m. after the sun at Greenwich, and the theoretical intensity of light is equal to that on May 16 ; on July 15, it sets 1h. 50m. after the sun, with a brightness equal to that on April 19.

On June 7, Mr. Barber, of Spondon, Derby, observed the comet with his 8-inch refractor, at 8h. 30m., or less than ten minutes after sunset : there was a large white disc, but no tail was visible at this time.

THE PLANETS FOR JULY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	6 17 1	N.18 38½	11″·5	23 35·4
	9th	6 9 16	N.19 8½	9″·9	22 56·2
	17th	6 24 20	N.20 35½	8″·0	22 39·8
	25th	7 3 59	N.21 48½	6″·5	22 47·9
Venus ...	1st	9 1 41	N.18 47	12″·6	2 23·6
	9th	9 39 27	N.15 47½	12″·1	2 28·3
	17th	10 15 46	N.12 23	12″·7	2 34·5
	25th	10 50 45	N. 8 39½	14″·3	2 38·0
Saturn ...	12th	3 26 38	N.16 35½	15″·4	20 2·2
	25th	3 30 54	N.16 49	15″·8	19 15·4
Uranus ...	4th	11 6 48	N. 6 31	2″·6	4 16·5

Mercury rises about the same time as the sun at the beginning of the month. By the end of the month he rises an hour and a half before the sun.

Venus sets about an hour and three quarters after the sun on the 1st, the interval decreasing.

Saturn rises an hour and a quarter after midnight at the beginning of the month, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR JULY, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Vega.
Sat	1		Sidereal Time at Mean Noon 6h. 37m. 44·94s.			11 53·3
Sun	2		Sun's Meridian Passage 3m. 43·28s. after Mean Noon			11 49·3
Mon	3		Saturn's Ring: Major axis=38″·28 Minor axis=15″·07			11 45·4
Tues	4					11 41·5
Wed	5	14 30 15 35	Occultation of B.A.C. 8152 (6½) Reappearance of ditto			11 37·5
Thur	6					11 33·6
Fri	7	9 51	☾ Moon's Last Quarter			11 29·7
Sat	8					11 25·7
Sun	9					11 21·8
Mon	10	5	Conjunction of Moon and Saturn 2° 38′ S.			11 17·9
Tues	11					11 13·9
Wed	12	2	Conjunction of Moon and Jupiter 1° 14′ N.			11 10·0
Thur	13	5	Conjunction of Moon and Mercury 0° 52′ S.			11 6·1
Fri	14	9 1	● New Moon			11 2·1
Sat	15		Illuminated portion of disc of Venus=0·779 Illuminated portion of disc of Mars=0·948			10 58·2
Sun	16		Sidereal Time at Mean Noon 7h. 36m. 53·29s.			10 54·3

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage
		h. m.			h. m. s.	h. m. Vega.
Mon	17		Sun's Meridian Passage 5m. 51·72s. after Mean Noon			10 50·3
Tues	18	7	Conjunction of Moon and Venus 6° 57′ N.			10 46·4
Wed	19	0	Conjunction of Moon and Mars 6° 16′ N.			10 42·5
Thur	20					10 38·5
Fri	21					10 34·6
Sat	22	22 17	☽ Moon's First Quarter			10 30·7
Sun	23		Saturn's Ring : Major axis=39″·39 Minor axis=15″·72			10 26·7
Mon	24					10 22·8
Tues	25					10 18·9
Wed	26					10 14·9
Thur	27	1	Conjunction of Uranus and Mars 0° 6′ N.			10 10·0
Fri	28	13 55	Near approach of B.A.C. 6536 (6½)			10 7·1
Sat	29	21	Conjunction of Uranus and Venus 0° 7′ N.			10 3·1
Sun	30	2 1 8 49 9 55	○ Full Moon Occultation of 8 Aquarii (6) Reappearance of ditto			9 59·2
Mon	31					9 54·3
AUG. Tues	1	23	Conjunction of Mars and Venus 0° 5′ N.			9 50·3

DUN ECHT CIRCULAR, No. 52.

The spectrum of the nucleus of Comet Wells deserves the closest attention, as it shows a sharp bright line coincident with D, as well as strong traces of other bright lines, resembling in appearance those seen in the spectra of γ Cassiopeiæ and allied stars.

Lord Crawford's Observatory,
Dun Echt: 1882, May 29.

RALPH COPELAND.
J. G. LOHSE.

Books received.—Report of Board of Visitors, Royal Observatory, Greenwich, 1882.—Effect of Railroad Trains in transmitting Vibration through the Ground. By Prof. H. M. Paul.—On Photographs of the Spectrum of the Nebula of Orion. By Henry Draper, M.D.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June, 1882.	To Sept., 1882.	To Dec., 1882.
Rylands, J. L.	Witty, E. A.	Banks, Mrs.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 236. AUGUST. 1882.

THE LATE C. E. BURTON.

We regret to have to announce the sudden death, from heart-disease, on the 9th inst., of Mr. C. E. Burton, of Loughlinstown, Co. Dublin, at the early age of 35.

Mr. Burton was the son of the Rev. Edw. Burton, rector of Rathmichael, in the Co. Dublin. He was an A.M. of T. C. D., and was for some years assistant to the Earl of Rosse at Parsonstown, where he learned the rudiments of the art of speculum grinding, in which he afterwards became proficient, some of his specula, silver on glass, of from 6 to 15 inches diameter, being unsurpassed. Their excellence, as well as Mr. Burton's skill in delineating what his telescope revealed, may be estimated by the views of the planet Mars, lately published in the Transactions of the Royal Irish Academy. The observations on which these views were founded were made with 8 and 12 inches specula, wholly the work of Mr. Burton's own hands. In fact our knowledge of the recently-discovered Martial canals is mainly derived from the observations of M. Schiaparelli and Mr. Burton.

Very shortly before his death he was engaged in taking photographs of the moon directly enlarged by the intervention of an eyepiece. For this purpose he employed the 7½-inch equatorial of his friend Dr. Erck, with an inch eyepiece. The diameter of the moon's disc, thus directly enlarged, was about 10-inches, with an exposure of from 8 to 16 seconds.

The advantage resulting from the enlargement of the image, without corresponding enlargement of the atoms of the film, was conspicuous. His experiments in this direction were cut short by preparations for the Transit of Venus Expedition, on which he was to have started in two days after the day of his untimely death. He had been engaged on the Servian expedition also.

His loss will be deeply felt by those who knew him well, for these laud him for his blameless life and courteous manners, as much as they respected him for his high scientific attainments and unsurpassed powers as an astronomical observer.

W. E.

*NOTE ON THE ZODIACAL LIGHT.**

It is designed in the present paper to make a brief record of the results obtained from observations of the zodiacal light extending over a period of nearly five years. The facts here presented are deductions from a large number of closely accordant observations, the publication of which in detail must be reserved for some future opportunity.

The discordant results obtained by different observers have induced the writer to take special precautions in his method of observation. To map correctly such very faint objects as those parts of the zodiacal light here called the zodiacal band and the gegenschein, requires absolute freedom from bias on the part of the observer. An atlas (Heis' Atlas Cœlestis) in which the ecliptic was not marked, was therefore used, and the gegenschein was plotted always without reference to the sun's longitude. Its angular distance from the sun was not calculated until after the close of the whole series of observations. In order to train the eye to more acute vision, it has been customary before each observation to use it in the detection of stars of the sixth magnitude and under.† It has been found that such practice is not only a good preparation for accurate observing, but that an idea of the comparative transparency of the atmosphere is thus obtained. In all cases the observations were made in perfect darkness, and recorded as soon after as possible.

Nearly all the observations were made in Germantown, Pa. (lat. 40°), but a few, especially those upon the "horizon light," were made at the sea-shore, on board ship, or on the mountains.

* *Note on the Zodiacal Light.* By Henry Carvill Lewis. (From the American Journal of Science, Vol. XX., December, 1880.)

† The writer has frequently seen twelve stars in the Pleiades with his naked eye.

The zodiacal light may be divided into three portions: the *Zodiacal Cone*, the *Zodiacal Band*, and the *Gegenschein*. This division, in addition to its convenience, saves confusion in description, and may be, in part at least, a natural one.

The Zodiacal Cone. This, the zodiacal light proper of most authors, and by far the most conspicuous of its three portions, has been frequently described, and its outlines mapped. It is, however, often misrepresented in popular works on astronomy. It is the only part of the zodiacal light which varies in appearance. Its height above the horizon and its brightness are directly connected with the duration of twilight and the obliquity of the ecliptic. The most favourable time for viewing it is always immediately after the last trace of twilight has disappeared. It would be more frequently noticed, but that it is often confounded with twilight. While the last trace of twilight is a lateral expansion of light along the western horizon, the evening zodiacal cone, of about the same shade of colour, rises obliquely as a cone, which is more or less pointed according to the season. Its apex occasionally attains a distance of 100° from the sun.

In this latitude the zodiacal cone is not a symmetrical figure, its southern side being more vertical than its northern side. Its southern side is also the more sharply defined of the two, and is the side more nearly parallel with the ecliptic. Its axis of greatest brightness does not correspond with its axis of symmetry, but lies south of it. There is a very small angle between these two axes. The axis of greatest brightness appears to lie precisely upon the ecliptic. The lateral extension of the base of the zodiacal cone, often observed, is probably a purely atmospheric effect.

The brightness of the zodiacal cone depends upon the season of the year, and the time of the night when observed. Its brilliancy increases rapidly as it approaches the sun, and at such times as it can be seen nearest the sun it always appears brightest. The time of shortest twilight coincides with the greatest brilliancy of the zodiacal cone. In each of the five years the evening zodiacal cone was most brilliant from the middle of February to the middle of March. Several observations have proved it to cast a distinct *shadow* at that time.* Numerous comparisons have been made between the brightness of the zodiacal cone and that of different parts of the Via Lactea, with the result that early in December of each year it becomes as bright as the Via

* Zodiacal light shadows were noticed on Feb. 12, 1877, at 7.15 p.m., and on Feb. 21, 1879, at 7.20 p.m. On the latter night snow covered the ground, on which distinct zodiacal light shadows were cast.

Lactea, soon outshining it in brilliancy, until in April it again begins to become the fainter of the two objects. During July and August the cone, now lying on one side along the horizon, can only be seen from positions whence there is a very perfect horizon, and at that season has generally been confounded with twilight. At the period of its maximum brightness, an *inner cone* of much greater brilliancy can be detected near the horizon. This short inner cone is less pointed in shape than the outer one, although fading by degrees into it. It is many times brighter than the Via Lactea, and is slightly coloured by atmospheric absorption. This inner cone appears directly above, and is suddenly obscured by the dark atmospheric *absorption band,* which is on the horizon.

Neither in this *inner cone*, nor in the zodiacal cone in general, has any colour, except what can be explained by atmospheric absorption, been proved by the observations under discussion. Although a decidedly warm colour has frequently been observed, it is found that this colour, like that of the moon and planets at low altitudes, is variable, and depends upon atmospheric conditions. Comparison between the zodiacal cone and the last traces of twilight or the glow preceding moonrise shows them to have a similar colour when equally bright. The zodiacal cone in the morning is frequently more pale than that in the evening, for the same reason that sunrise has generally less deep colours than sunset.

Several observations indicate that the light of the zodiacal cone has a great penetrating power. Even under atmospheric conditions in which the Via Lactea is made nearly invisible the zodiacal cone appears to lose but little of its light. The light is dense, though dull and ill-defined, and the impression is given that the matter producing it has great depth.

Careful watch has been made for any pulsations in the zodiacal cone. Although aware of the statements of some observers, as to their existence, the writer, during the whole of his observations, has never once been able to detect any certain pulsations, any movement, or any sudden change in brightness in any part of the zodiacal light, and he believes that all such apparent effects are due either to atmospheric changes or to changes in the eyesight of the observer. Since frequently an apparent diminution in brightness ensues after the observer has been looking at another part of the sky, and especially after recording a note by lamplight, it has been found necessary to compare directly the brightness of the cone at a certain altitude with a definite portion of the Via Lactea, and it was then always noticed that the diminution in brightness of the zodiacal cone was accompanied by a corresponding

change in the Via Lactea. Any change in the transparency of the atmosphere or in personal judgment affects equally both phenomena.

Not only have no pulsations been observed, but as yet no periodic variations in the appearance or brightness of the zodiacal cone have been noticed. The photometric observations were only approximate, but, so far as could be judged, the zodiacal cone each year went through the same series of changes; attaining each winter, at the time of its maximum brilliancy, an equal degree of brightness, and becoming equally faint each summer. The statements, which others have given of its remarkable brilliancy during the appearance of certain comets or other noticeable phenomena, may be accounted for on the hypothesis that at such times special attention is directed towards a certain class of celestial objects, and a phenomenon generally ignored is thus brought to special notice. The observations of the writer tend to prove the invariability of the zodiacal light. The difference in its appearance is thought to be due merely to the different positions of the earth in reference to it.

Nor has the *moon* been discovered to have any action upon the appearance of the zodiacal cone. The zodiacal cone is frequently sufficiently bright to enable it to be seen when the moon is either in it or higher in the heavens. The presence of the moon does not appear to alter its shape. When the moon is above the zodiacal cone, but not on the ecliptic, it has been frequently observed that the axis of the cone points away from the moon, making with it a considerable angle. Again, the cone is found to preserve its shape, both while the moon lies within it, or on one side of it, or when, after having passed its first quarter, the moon illuminates it from above. The widening of the base of the zodiacal cone, as the moon lights up the horizon, is an atmospheric effect caused by the brightening of the "horizon light."

The writer has taken several observations upon the *spectrum* of the zodiacal cone. Three different spectroscopes, of different make,* have been used with accordant results. It was of interest to find that, notwithstanding the brilliancy of the cone when observed, nothing whatever could be seen when using a narrow slit—a fact proving the continuous character of the spectrum. When a slit of over a millimeter in width was used, there appeared a faint, pale, continuous spectrum, brightest and most abruptly ending at the less refrangible end, and gradually fading

* Browning's one prism, Browning's direct-vision, Eaton's direct-vision, —the last being the most satisfactory.

at the other extremity. The slit was too wide to permit Fraunhofer lines to appear. The spectrum was of a pale greenish-gray colour throughout, and was not unlike that given by late twilight. The peculiar ashy-gray colour of this spectrum, which lies between the yellow and the green of the solar spectrum, and forms its most luminous portion, is probably characteristic of all very faint polychromatic lights. It is the last portion of the spectrum to disappear, and is nearer white than any other colour. The spectroscopic observations of the writer agree with the more careful work of Smyth and Wright, and point to reflected sunlight as the source of the light of the zodiacal cone.

The Zodiacal Band.—The zodiacal band is one of the faintest visible objects in the heavens, and has thus escaped the attention which it deserves. It may be described as an extremely faint zone of light, somewhat wider than the Milky Way, which, like a narrow slip of gauze, is stretched across the sky along the zodiac from horizon to horizon, and which can be seen at all times of the year, and at all times of the night. It is a belt with parallel sides, of nearly equal width throughout, which, as though a second and much fainter Milky Way, forms a faint prolongation of the zodiacal cone across the sky. It is most favourably situated for observation at the same season of the year in which the zodiacal cone is best seen, when it forms a high and perfect arch from east to west. It is so faint that in order to detect it at any time it is necessary for the observer to make out first the darkest places in the sky, shifting the eyes rapidly and continuously along the sky, from north to south and the reverse, and thus by degrees to narrow the vision down to the faint band of light upon the zodiac. It is most easily seen late in the evening, after the zodiacal cone has sunk below the horizon, since the brightness of the latter is apt to dim it by contrast. It is also of course best seen when it makes a large angle with the Via Lactea, or when the latter is on the horizon.

The zodiacal band is brightest along an inner line, whence it fades off very gradually towards the edges. When most favourably situated, it seems to be more sharply defined on its southern than on its northern edge, and in this respect is similar to the zodiacal cone. Toward midnight the zodiacal band is decidedly brightest at the highest portion of the arch, where it contains the third division of the zodiacal light—the gegenschein. The width of the zodiacal band can only be very approximately estimated. As generally seen, it has perhaps a width of about 12°. When low down towards the southern horizon this width is apparently greatly increased, and the horizon light interfering, the whole southern sky beneath the Via Lactea may be seen illuminated,

On rare occasions it is possible to detect an inner zone of greater brightness, some 2° wide. At such times the principal band of light has a width of 5°—6°, while beyond and on either side a very diffuse portion measures from edge to edge as much as 20°. This diffuse portion is particularly noticeable on the northern edge. It must be understood that each of these portions shade by insensible degrees one into the other, and that probably no two observers would give the same widths.

The zodiacal band lies in the zodiac, upon or close to the ecliptic. The observations appear to show that while its axis of greatest brightness is either on or very slightly north of the ecliptic, the axis of symmetry is decidedly north of that line. Probably in the southern hemisphere the reverse would be the case.

The zodiacal band is generally quite obscured in the presence of the moon, but two or three observations are recorded, in which it has apparently been seen by moonlight. That such an extremely faint object should be seen by moonlight, as though illuminated by it, is an interesting fact, which, however, is not as yet sustained by sufficient observations.

The Gegenschein.—This term, given by Brorsen to a light which appears opposite to the sun, but which has been confused by others with the eastern part of the zodiacal band, is here limited to the round or oval spot of light which nightly appears at that place in the zodiacal band which is 180° from the sun. The writer has paid particular attention to the observation and careful mapping of this object. He has made more than 40 maps of its position among the stars at different times, and upon subsequent calculation he has found that almost without exception the centre of the gegenschein thus mapped lies within 1° or 2° of a point in the heavens 180° in longitude from the sun.

The gegenschein is an extremely faint spot of light some 7° in diameter, lying in the zodiacal band. It is best placed for observation about midnight, and can be detected by shifting the eye backward and forward along the zodiacal band. Any one who looks for it in February and March, when the Via Lactea is low on the horizon, cannot fail to find it, first in Leo and afterwards in Virgo. Night after night it shifts its place among the stars, so as to keep opposite the sun. It is of course invisible when crossing the Via Lactea.

The gegenschein is decidedly brighter than the zodiacal band, although always much fainter than any central portions of the Via Lactea. It often appears to form an oval whose major axis is parallel to the ecliptic. At such times its major axis may be 15° in length. This effect is probably caused by the brightness

of the zodiacal band on either side of it, for careful observations show that the brighter portion is approximately circular.

Sometimes a *nucleus* of greater brightness has been noticed in the centre of the gegenschein. This nucleus is a small definite circular spot, of about 2° in diameter, and is only to be detected under favourable atmospheric conditions. Several maps have been made of the position of this nucleus. Generally the gegenschein appears as a nebulous patch of equally diffused light.

Perhaps the most interesting fact concerning the gegenschein which is clearly deduced from the maps of its position is that it always lies some 2° $\pm$ *north of the ecliptic.* While a number of observations placed its centre 3°—4° north of the ecliptic, not a single one makes it south of that line. This fact will be of importance in a theory of the gegenschein.

The extreme faintness of both the gegenschein and the zodiacal band made it impossible to obtain any spectrum other than that given by diffuse star light.

Mr. Lewis then gives an explanation of the plate accompanying his paper, representing observations of the gegenschein taken while it was near the vernal equinox; and he goes on afterwards to discuss—

The Moon Zodiacal Light.—A phenomenon is described under this head, by the Rev. George Jones (*U. S. Japan Exped.* III. 329 *et seq.*), in his interesting series of observations upon the zodiacal light, as a short, oblique cone about in the plane of the ecliptic, seen in the immediate proximity of the moon. He observed it several times, just before moonrise. It may have been owing to an inferior horizon, but although careful search was made, at no time has the present writer been able to detect any such appearance. The light which precedes the rising of the moon is found uniformly to rise at right angles to the horizon. This light spreads out laterally along the horizon, and appears to be a purely atmospheric effect. . . The writer has not as yet been able to recognise in his observations any direct connection between the zodiacal light and the moon. The aurora appears to have no influence whatever upon any portion of the zodiacal band.

The Horizon Light.—More than once in this paper reference has been made to a light which it has been found convenient to designate by the above name. It has no connection whatever with the zodiacal light, but since it is continually observed with that phenomenon, and at certain seasons of the year blends with and is apt to be confused with portions of it, it is necessary to take it into account. Unlike the zodiacal light, it is a terrestrial effect.

The horizon light is a faint band of white light with parallel

sides, lying all around and parallel to the horizon, and separated from it by an interval of darkness. It is seen on every clear night, and at all times of the night. This band of light is most bright and terminates most abruptly on its lower edge. Its upper edge fades off very gradually into the sky. Its comparatively sharp lower edge is at an altitude of some 5° above the horizon. The diffuse upper edge varies in altitude with the state of the atmosphere. On clear nights it has probably a mean altitude of 20° ±, the horizon light being therefore some 15° broad. The clearer the night the narrower is the horizon light. On hazy nights it reaches far up towards the zenith. At such times it is possible that artificial earth-lights aid in its extension. The horizon light disappears when the sky is overcast.

Its brightness is variable. At times its lower portion seems as bright as the Via Lactea, and at other times is fainter than the gegenschein. When the moon is in the sky it becomes exceedingly bright and wide, far surpassing the Via Lactea. Just before the rising of the moon it widens out on both the east and west horizons. Stars are readily seen through the horizon light, and are but slightly dimmed in lustre. The horizon light can most easily be detected by inclining the head towards the shoulder and glancing from the zenith to the horizon. The horizon light appears to be caused by reflected starlight. That diffuse sky-light is sufficiently bright may be proved by noting its power to cast a shadow.

Below the horizon light and resting upon the horizon is a dark space which we may designate the *Absorption Band.* It is darker than the sky at the zenith, and quenches all faint celestial light. The Via Lactea ends abruptly at its upper portion, and the zodiacal cone, even when very bright, extends only slightly into it. Their comparative brightness may be estimated by noting how low down they penetrate the absorption band. No stars can be seen through its lower portion and rarely through its upper part, at such times being deeply coloured. The moon and the larger planets are coloured red while in it. The absorption band is some 5° broad, and is of course only seen when the observer has a perfect horizon. In the study of the zodiacal light it is important that both the horizon light and the absorption band should be recognised. In the summer, when the ecliptic is low and the zodiacal band lies far down towards the southern horizon, the horizon light frequently blends with it, greatly interfering with its determination. The two illuminate the southern sky, and it is difficult, if not impossible, at times to separate one from the other.

Conclusion.—Other observers have contributed much of importance concerning the phenomena of the zodiacal light, and several

theories of its origin have been proposed. No theory is advanced in the present paper, and as the observations are being continued, these partial results alone are presented as a contribution to the store of facts already collected on this interesting phenomenon.

Germantown, Pa.: August, 1880.

The aurora of May 2, 1877, was seen in conjunction with the zodiacal light, and direct comparisons could be made between the two phenomena. From another paper by Mr. Lewis on this subject, we extract the following; after describing the aurora, he continues: "At 9.33, the zodiacal cone being now low down towards the horizon, and pointing towards Præsepe, a very remarkable auroral streamer formed low down in the west. . . It was thus close to the edge of the zodiacal cone. The streamer remained in the same position for nearly an hour. It was remarkably steady, and was not unlike a pale grayish-green comet's tail. For the first ten minutes it was without any fluctuations. . . At 10.03, the rest of the aurora was thin, and no other streamers appeared. It was now very conspicuous, and remained so until nearly half-past ten, when it finally died away—a faint haze on the northern horizon alone remaining. All this time, as seen from the position of this streamer at the back of certain trees and its angle with the horizon, it had maintained precisely the same position with reference to the earth.

"Meanwhile, the heavens had revolved past it, the stars first noticed had moved beyond it, and the zodiacal cone had set. The streamer had remained like a great pointer fixed to the earth, marking its motion, while the zodiacal cone gradually sank below the horizon, the auroral streamer had retained its position—a circumstance well illustrating the cosmical character of the former, and the terrestrial character of the latter. Another fact pointing to the same conclusion was found in the difference of their spectra. In the early part of the evening, while both the zodiacal cone and the aurora were at their brightest, an opportunity was taken to compare their spectra. The observations were made with Eaton's direct-vision spectroscope. The zodiacal cone gave a faint, short, continuous spectrum, brightest near its least refrangible end. It was most sharply terminated at the same end, fading off gradually toward the more refrangible end. It was very faint throughout, and could be seen only through a wide slit. The aurora gave a spectrum much longer than that of the zodiacal cone, though of about the same pale greenish colour. At or close to the less refrangible end was a sharp bright line of a greyish-green colour.

The spectrum from this line towards the more refrangible end was continuous and gradually diminishing in brightness, except that a very faint brightening near the blue showed that a brighter aurora might have given a line at that place. The green line of the aurora could be seen with a very much narrower slit than that required to see the spectrum of the zodiacal cone. If the spectra of the aurora and the zodiacal cone could be superposed, it would be found that the green line of the former is close to the more refrangible end of the spectrum of the latter. The spectra show that while the light of the zodiacal cone is polychromatic, that of the aurora is nearly monochromatic, or as it might be expressed *oligo-chromatic*. The former is such as would be given by sunlight reflected on diffuse matter in space, the latter might be given by an electrical discharge through a gas.

Later in the evening the faint zodiacal band was observed stretching completely across the sky, along the ecliptic, while a round patch of light on the boundary between Virgo and Libra lying apparently about 3° above the ecliptic, is recognised as the gegenschein.

It is perhaps worth noting that no change of consequence in the weather or temperature took place during the two or three days preceding and following this aurora.

The above paper contains such an excellent description of the zodiacal light, and the special features to be remarked in it, that it will, we trust, be found useful to those who are engaged in its observation, and may perhaps lead others to begin its study. Its importance is unquestionable. For some account of its probable relation to the solar corona we may refer to Proctor's "Sun," pp. 385—389 (third edition). Those who have access to the Edinburgh Astronomical Observations, Vol. XIV., will find some fine coloured plates of the zodiacal light, and of auroras, and of their respective spectra, by the Astronomer-Royal for Scotland. The zodiacal light observations were made at Palermo under very favourable circumstances.

OBSERVATIONS OF JUPITER.

It will greatly assist observers of Jupiter during the coming months if they are provided with a good account of the principal facts that were noticed during the opposition of 1878, and for this purpose they cannot do better than obtain the paper of M. Niesten, which appeared in the Annals of the Brussels

Observatory, and which is published by "M. Hayez, Imprimeur de l'Académie Royale," in that city.*

M. Niesten's observations were made with a Merz refractor of 15 centimeters, "useful aperture," corresponding within a trifle to 5·9 inches English measure, and of 2m.60 focal length. The powers usually employed were 180 and 270, and occasionally higher, in very fine weather. The results are displayed in four dozen beautifully executed drawings on stone, done by the observer himself. These are arranged in order of longitudes, the dates and times being given in the text. Thus, if Mr. Marth again supplies us means of ascertaining the central meridian of the planet at any hour, exact comparisons may be easily made.

In the central zone, which astronomers have agreed to designate *3* 1 1, the permanence and continuity of white spots was very remarkable. The great red spot was sometimes invisible—then in a position to be well seen—indicating that it was concealed by vapours in the planet.

Various changes of colour were noted by M. Niesten, but none were very remarkable. The temperate northern zone nearly always exhibited a slender dark band (4). The north polar region (5) was continuously dark, as compared with the south polar region, which was pale yellow contrasted with the former.

Measures were made of the longitude of the centre of the great red spot, which seemed to show that it had a proper motion; retrograde in July, August, and September, and direct in October and November. This requires further investigation, as the measures are given only as approximate, and it remains to be ascertained whether the great spot is fixed or like a floating continent, a possible thing in a consolidating globe.

H. J. S.

REVIEWS.

From the *Sidereal Messenger*, conducted by Wm. W. Payne, Director of Carleton College Observatory, for June, we learn that Professor Ormond Stone, of the Cincinnati Observatory, has been appointed Director of the Leander McCormick Observatory, of the University of Virginia. The institution is in possession of the great refracting telescope made by the Clarks a few years ago, for Mr. McCormick, who generously presented it to the university in 1877. It cost nearly 50,000 dols., and is said to be not inferior to any telescope in the United States. The friends of the university have contributed 75,000 dols. to endow the chair of astronomy. By a late report of the Board of Visitors, a most commendable outlay in the interest of scientific research is shown.

---

* Observations sur l'Aspect Physique de Jupiter pendant l'Opposition de 1878. Par L. Niesten, Astronome à l'Observatoire Royal de Bruxelles. F. Hayez, Imprimeur de l'Académie Royale. 1880.

The death of Rear-Admiral John Rodgers, Superintendent of the U. S. Naval Observatory, on May 5th, is greatly regretted. He was eminent as a naval officer and in scientific attainments.

Dr. Draper's photographs of the great nebula of Orion and of its spectrum are spoken of by private viewers as specimens of high art. They will be issued probably with the next volume of the Washington observations.

The flint disc for the 36-inch objective to be made by Alvan Clark and Sons for the Lick Observatory is 38·19 inches in diameter and 21·65 inches thick. It weighs 375 lbs. A month was required in the cooling. A crown disc has also been cast by M. Feil (fils) who made the flint.

The *Sidereal Messenger*, a monthly review of astronomy, stated to be the only periodical in the United States devoted exclusively to popular astronomy, is well deserving of the support we trust it will yet more receive. The present number has the concluding part of Mr. S. W. Burnham's *Hints on Double-star Observing*, and much other interesting matter. It may be well to mention again that the price of the ten annual numbers is 2·00 dols., and that all communications should be addressed to the Editor, Northfield, Minnesota.

On Photographs of the Spectrum of the Nebula in Orion. By Henry Draper, M.D. From the "American Journal of Science," Vol. XXIII., May, 1882.

To photograph the nebula, Dr. Draper tells us, required an exposure of more than two hours, and an exceedingly minute motion of the stars relative to the sensitive plate will become apparent on account of the high magnifying power (180) employed. Photographs of the spectrum led to the discovery of two condensed portions of the nebula just preceding the trapezium, which give a continuous spectrum. At those places there is either gas under great pressure, or liquid, or solid. In one of these photographs the spectrum of a star of the tenth magnitude is easily discerned. That the light of so faint an object, even when dispersed into a spectrum, is capable of being photographed, is a remarkable achievement.

No. 5, for July, of M. Flammarion's *Astronomie* has an article by the editor on the planet Mars, with illustrations and maps; the conclusion of his paper on the physical and chemical constitution of comets, illustrated. The eclipse of May 17, as seen at Paris and in Egypt, with illustrations, one of which shows the comet near the sun. The comet *Wells*, with chart of its path in the heavens, and a variety of other matters. M. Flammarion applies the researches of Crooke on radiant matter to the explanation of the tails of comets, which he regards as simply the interplanetary medium itself illuminated. Showing that M. Faye's theory is inadmissible, he thinks it probable "that comets are bodies which on approaching the sun become electrified, their substance is diffused and reaches the condition called *radiant*. Subsequently a more wonderful phenomenon takes place: the comet produces in space on the side away from the sun a luminous excitement capable of extending to millions and millions of leagues, but there is no matter thereby taken from the comet. How does all this happen? It is precisely what has to be investigated. The advances of future science will decide. *Felix qui potuit rerum cognoscere causas.*" We need hardly repeat that *Astronomie* is a periodical of high excellence, and it will certainly form at the end of the first year of its existence a handsome volume of great and permanent interest.

Observations des Comètes b *et* c *de* 1881, *faites à Louvain.* Par M. F. Terby, Docteur en Sciences. (Présentées à la Classe des Sciences dans la Séance du 6 Octobre 1881.) Extrait des Mémoires de l'Académie royale de Belgique; Collection in 8vo, tome XXXIII.

These observations are accompanied by charts and figures. M. Terby employed the telescope by Secretan, with powers of 38, 80, 120 and 180 (3½-in. aperture), and a binocular by the same. He paid particular attention to the situation of the tail of comet *b* amongst the stars. This comet was observed from June 23 to July 18. Comet *c* from August 17 to 28.

Introduction to Greenwich Astronomical Observations, 1880. pp. cxxx.

The observations contained in the present volume were made and reduced under the superintendence of Sir G. B. Airy, K.C.B., as Astronomer-Royal, before his resignation of that office in 1881, August 15. There is the usual description of the instruments, their adjustments, methods of observation, corrections, personal equations, &c., with a large number of formulæ employed in the different branches. The horizontal circle of the altazimuth was redivided in this year by Mr. James Simms, the divisions in some places having been obliterated in course of time. A table is given of the division corrections. From 1880, Sept. 10, the observations of a moderately-distant azimuth mark have been used in combination with stars for determining the zero of azimuth. This mark is fixed on the parapet of the Royal Naval College, at a distance of about 1730 feet from the altazimuth.

Subjects of observation, 1880. The sun has been observed on the meridian at every practicable opportunity, except on Sundays; the moon and moon-culminating stars have been observed at every opportunity without exception. The inferior planets, Mercury and Venus, have been observed on the meridian at every practicable opportunity, excepting Sundays. The superior large planets, Mars, Jupiter, Saturn, Uranus, and Neptune, have not generally been observed when their solar time of meridian passage is greater than 15h., excepting at times when the moon passes the meridian later than 15h. The small planets have been observed only when the time of meridian passage is earlier than 13h. The observations of all planets are intermitted on Sundays. In the meridional observations of the stars, it has been considered as the first object to establish with indisputable accuracy the places of those included in the *Nautical Almanac* list (as far as they are visible in this latitude), together with 56 other stars which are used in connection with the *Nautical Almanac* list stars, for determining clock error. The other stars observed are principally circumpolar stars with polar distances up to 40°, both above and below the pole; about 850 stars used for determination of zenith points; moon-culminating stars from the list in the *Nautical Almanac;* stars whose occultations by the moon are visible at Greenwich; variable stars; stars which pass near the north or south horizon; stars suspected or known to have large proper motions; stars of which observations have been requested by astronomers for special purposes. The altazimuth has been used for observations of the moon on every day when she could be seen, without exception. . . . The reflex-zenith tube has been used throughout the year for observations of γ Draconis. The assumed co-latitude is 38° 31′ 21″·90. The transit-circle observations of 1880 give a correction —0″·007, which makes the co-latitude from the observations of 1880, 38° 31′ 21″·89. The assumed co-latitude of the

altazimuth is 38° 31′ 22″·19, being 0″·29 greater than that of the transit-circle, as found by measurement on the plan of the observatory. From a comparison of the observed vertical diameters with the tabular diameters of the moon made from the erection of the transit-circle, to the end of 1863, it appears that Hansen's semi-diameter requires to be increased by +0″·18, in order to represent the observations of diameter made with the transit-circle. The mean of 14 determinations of the error of the moon's tabular vertical diameter made in 1880 is —0″·29. Differences of R.A. and N.P.D. of the limbs and cusps were observed in the solar eclipse of 1880, Dec. 31, and equations deduced therefrom. Phenomena of Jupiter's satellites were observed and compared with the *Nautical Almanac*, and equations deduced from occultations of stars by the moon. Spectroscopic observations were made on the sun and stars, and the comet 1880 *d* (Hartwig's). The original entries of observations are in all cases preserved, as also the solar photographs which have been measured.

The Introduction to the Greenwich Observations makes us acquainted with the means taken to eliminate all possible sources of error in the use of instruments of first-rate excellence, yet of necessity imperfect. It is to some extent a treatise on the refined methods of modern practical astronomy, and interesting even to those who are not concerned with the handling of large and fixed instruments. We have here one more contribution from the master mind now withdrawn from the direction of the Royal Observatory. In common with very many we wish for Sir George Airy a long season of health and happiness, and that in a retirement ennobled by past labours he may be permitted to complete his great and important work on the lunar theory.

OBSERVATORY OF PARIS.

Ephemeris for the search for the Comet 1812 (*Paris*).

By MM. Schallof and Bossez.

The comet of 1812 was discovered by Pons at Marseilles, the 20th July, and by Bonvard at Paris the 1st August. Parabolic elements were given by Bonvard, Oriani, Triesnecker, Nicollet, Verner. Encke was the first to discover the impossibility of representing observations by a parabola. The elliptic elements which he has given assume that the comet has a period of revolution of 70·68 years. By a new discussion of the observations we have found from the more probable elements a period of 71·7 years. On the other hand the perturbations experienced allow us to infer that the comet will return to perihelion about the middle of 1883. The uncertainty of the period of revolution being $\pm 3\frac{1}{2}$ years, it is desirable that a systematic search for the comet should be undertaken at once.

The ephemeris presented contains all the positions in which the comet might be found on a given day during three months (August—October). . . The 25 positions give the curve in which the comet should be looked for.

We give an abridged extract from this extensive table. Degrees of true anomaly at the top. α R.A., δ Declin. We have omitted the columns of true anomaly above +75° for want of space. The declinations assigned in them are very low S. The original table has true anomaly for every arc of 7½°. We have copied 12 positions for four days. Sun's long. is the more precise argument of the table, but the days of the month will suffice :—

Ephemeris for the search for the Comet of 1812.

Sun's Longitude.		True anomaly of the Comet.					
135°		90°	—75°	—60°	—45°	—30°	—15°
Aug. 7	α	7h. 30m.	7h. 9m.	7h. 8m.	7h. 11m.	7h. 16m.	7h. 22m.
	δ	+73°·9	+58°·9	+46°·6	+36°·4	+27°·7	+20°·0
		0°	+15°	+30°	+45°	+60°	+75°
	α	7h. 29m.	7h. 38m.	7h. 50m.	8h. 5m.	8h. 25m.	8h. 54m.
	δ	+12°·7	+5°·6	—1°·6	—9°·2	—17°·5	—26°·7
145°		90°	—75°	—60°	—45°	—30°	—15°
Aug. 18	α	8h. 50m.	7h. 52m.	7h. 41m.	7h. 39m.	7h. 41m.	7h. 46m.
	δ	+74°·9	+60°·1	+47°·3	+36·5	+27°·2	+18°·9
		0°	+15°	+30°	+45°	+60°	+75°
	α	7h. 53m.	8h. 2m.	8h. 13m.	8h. 28m.	8h. 49m.	9h. 19m.
	δ	+11°·2	+3·°8	—3°·6	—11°·3	—19°·5	—28°·3
150°		90°	—75°	—60°	—45°	—30°	—15°
Aug. 23	α	9h. 33m.	8h. 15m.	7h. 57m.	7h. 53m.	7h. 54m.	7h. 58m.
	δ	+75°·0	+60°·7	+47°·6	+36°·5	+26°·9	+18°·3
		0°	+15°	+30°	+45°	+60°	+75°
	α	8h. 5m.	8h. 13m.	8h. 25m.	8h. 40m.	9h. 1m.	9h. 31m.
	δ	+10°·4	+2°·8	—4°·8	—12°·6	—20°·7	—29°·3
160°		90°	—75°	—60°	—45°	—30°	—15°
Sept. 2	α	11h. 0m.	9h. 4m.	8h. 32m.	8h. 22m.	8h. 20m.	8h. 23m.
	δ	+74°·4	+61°·8	+48°·4	+36°·5	+26°·1	+16°·8
		0°	+15°	+30°	+45°	+60°	+75°
	α	8h. 28m.	8h. 36m.	8h. 48m.	9h. 3m.	9h. 25m.	9h. 56m.
	δ	+8°·3	+0°·3	—7°·5	—15°·4	—23°·4	—31°·4

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.
To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

LARGE METEOR OF JUNE 7, 1882.

Sir,—The observation of a brilliant white meteor on June 7, > ♀ by the Rev S. J. Johnson (*Register*, July, p. 166) is interesting as affording additional proof of the fireball epoch, June 6—7, to which I recently directed attention (*Register*, June, p. 139). From Mr. Johnson's description, the apparent path was from about $115° + 36°$ to $132° + 11°$, so that the meteor traversed a course of some 29° through Cancer. Its extremely slow motion and fairly long path, as it descended to near the W. horizon, sufficiently proves that this fireball was a considerable distance from its radiant point—probably situated in the western extremity of Pegasus. The meteor could hardly have belonged to a shower in Lacerta (though the direction of its path conforms to the position of a radiant there) because its very gradual flight is quite opposed to the swiftness of the June *Lacertids*. Nor could this fireball have been directed from the same radiant (near Antares) as that which furnished the fine meteors of June 7, 1878. It would be important to hear of a duplicate observation of Mr. Johnson's meteor.

Ashley Down, Bristol: W. F. DENNING.
July 1, 1882.

PTOLEMÆUS.

Sir,—In the *Astronomical Register* for February, 1882, p. 45, are a few lines on some observations of the most northern of the two deep pits delineated by Schröter on the floor of Ptolemæus, and nearly as large as the crater *A*, but which do not seem to have been noticed again previous to those observations. On the 23rd June, 1882, moon's age 8·1 days, a short view of great interest was obtained with a power of 102 on a 2·75-in. achromatic, for not only was the above-mentioned object seen again, but also Schröter's large, more southern pit, even more striking and conspicuous than the other.

Both these remarkable depressions were but little inferior in size to the crater *A*, and were nearly, but not quite, filled with shadow. The southern pit had a slight extension of the shadow

southwards, whilst from the east and west sides of the northern one, two nearly parallel ridges ran northwards, the space between which being nearly filled with shadow indicated a considerably depressed surface.

Previous to June 25, it is somewhat remarkable that not a trace of either of these very conspicuous objects had been seen at a later period of the moon's age. On May 27, 1882, for instance, when the moon's age was 8·4 days, the floor was carefully examined for this purpose with a power of 275 on a $5\frac{1}{4}$-in. Calver reflector, but without success. On June 25, however, though the form of neither of the pits could be certainly made out, yet a little shadow was suspected under what would be the place of the west wall of the southern pit, and on June 26 this pit was seen as a slightly darker patch, a little shadow being again suspected under the west wall. On June 27 also an ill-defined dark patch was seen in the place of this great southern pit.

West Brighton: Yours faithfully,
July 8, 1882. A. STANLEY WILLIAMS.

THE SOLAR ECLIPSE OF MAY 17, 1882.

At 6h. 29m. a.m., I obtained my first view of the partially eclipsed sun, which was now visible to the naked eye if protected with a coloured glass screen.

Observing with a small equatorial refractor by Jones, of $1\frac{1}{2}$-inch aperture and P. 20, the first phenomenon that presented itself was a violet fringe, which made its appearance along the moon's limb at 6h. 35m. a.m., and remained visible in whatever part of the field of view it was observed, until 7h. 8m. a.m., after which time it was not seen. I noticed that if the eye was removed from the telescope for a few moments, the fringe did not immediately make its appearance, requiring about two seconds in which to do so.

At 7h. 12m. a.m., the eclipse was not visible to the naked eye.

Comparing the colour of the solar spots with the body of the moon, I found that the nuclei of a rather large group which was very near the moon's limb were of a brownish hue in comparison with the intensely black body of the moon. The other groups (all of which were at a considerable distance from the moon's limb) appeared of a greyish black in comparison, excepting an almost circular spot near the sun's following limb. This spot, which had barely any penumbra, was as intensely black as the body of the moon itself. It would be interesting to know whether a similar comparison was made by any other observer.

B. J. HOPKINS.

TRANSIT OF MARS OVER PRÆSEPE.

Sir,—At the close of last month my attention was attracted by the interesting spectacle presented by Mars in connection with the bright stars Castor and Pollux. I remember the planet was then in a straight line with those stars, and at a distance south of the latter somewhat greater than the space between the stars themselves. By a casual comparison of its position on the evening of the 10th instant with that which it formerly occupied, it was apparent that the planet was moving almost if not quite directly towards Præsepe, the well-known cluster in Cancer. My attention being thus strongly drawn to the subject, I found by an examination of the ephemeris of Mars that the planet would actually transit the group about the 19th instant, Greenwich mean time. As I was not aware that the phenomenon had been foreseen by any astronomer, I immediately published a notice in our daily newspaper, the *Herald*, and also communicated with the observatories at Sydney and Melbourne, in the hope that the planet might be observed to occult some one or more members of the group. I observed the planet just within the limits of the cluster, on the evening of the 18th, but the sky was unfortunately overcast on the following three evenings. As the conditions would obviously be more favourable in Europe for observing the phenomenon, I trust it has been noticed there. Even if no occultation has been observed, the transit itself must have been exceedingly interesting.

Observatory, Windsor, I am, Sir, yours faithfully,
N. S. Wales: 1882, May 25th. JOHN TEBBUTT.

SOLAR HALO.

12 July, 7.53 p.m. Sun, sinking through stormy wisps of cirrhus, formed a large halo about 25° radius, top of arc about 35° above horizon, measured with Herschel's card quadrant; colours opalescent, red inside. faded in less than a quarter of an hour. Folks in a balloon seen north of sun may have noticed something remarkable in the state of the air.

Ashdown Cottage, Forest Row: HENRY J. SLACK.
July 14, 1882.

DUN ECHT CIRCULAR, No. 53.

A *Science Observer* telegram announces that Mr. S. C. Chandler, Jun., finds the period of the variable star D. M. +1°·3408, which forms the subject of Dun Echt Circular No. 41, to be only 0·83 days. A minimum occurs on July 1, 12h. 57·6m. G. M. T.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, June 29.

LUNAR WORK FOR AUGUST, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

On the evening of July 4th, at 2h. 30m. to 4h., Miss Ashley was observing the region between *Beaumont* and *Theophilus* (see *Lunar Work* for May, page 117). She says that the ring and the second ridge, to which I had called attention, were not visible, but she noticed a number of minute craters in the position of the two black spots west of the ridge. It was not the first time she had seen them, and she had marked down the principal ones, two of them being evidently the two in the dark spots. Most of them were just at the limit of what she could see, and on the east side of the ridge were a good many more of the same size. Under other illuminations she has often seen the crater in the southern spot, which is the more easily seen of the two. On this occasion its west wall was much the more brilliant. The floor of Beaumont contained several objects which she believed to be craters, and on the west side of the *Mare* there were a good many craters not shown in the map, some of which she had seen before.

The observations show that the whole region is one of considerable interest, and will repay careful attention.

Ptolemæus. The following note from the observation-book of Mr. Herbert Ingall is quoted from the *English Mechanic*. It is, as Mr. Ingall remarks, another instance which tends to strengthen a lurking idea always present in his mind, of an obscuring medium on the lower levels of the moon; the region should be well watched under varying conditions of illumination:—

"1866, April 22nd. I obtained some good views of Ptolemæus, which was on the terminator, and was much struck by the irregularities of its surface. The principal crater *A* was of course most conspicuous. There appeared to be a wall or low ridge running north of it, and also a mound to the north-west. The surface of the plain (generally as smooth as water) appeared much diversified with numerous shallow depressions (I cannot call them craters) which were generally very large. It was difficult to trace out the smaller crater *B*, which stood between four of these hollows, appearing to be on the summit of a mound, and having four bright ridges running from it (after the style of *Copernicus*, but the ridges were more rocky and high). I have never seen this appearance of the little crater before, always imagining that it stood on the smooth surface. This shows how careful we should be in not arriving at conclusions from a few observations. The appearance and sketch of the crater was confirmed by my brother William, who observed it some time and drew my attention more particularly to the small mound north-west of the principal crater. The small crater *B* could not be seen with a lower power than 225."

The crater Mr. Ingall here calls *B* is not shown in either Neison's or Beer and Mädler's map, and requires confirmation.

St. Mary's, Bayswater:
July 20, 1882.

District Catalogue of Ptolemæus.

The origin of measures is *Ptolemæus A*.
Unit of distance is $\frac{1}{124}$ of moon's diameter.

Name.	*Object.*	P.	D.
Ptolemæus	A large walled plain.		
A	A deep crater 7° bright, in lat. —8° 56′ and long. —0° 44′ (Mädler)		
b	A valley north of *A*	0	·5
c	A craterlet on the S. part of floor	115	2·2
d	A crater, 5° bright, on the N. part of floor	70	2·0
e	A rill-like valley east of λ	90	4·3
f	A small crater N.W. of *Ptolemæus*	295	1·6
g	A crater on N.W. wall	330	1·0
m	A very small crater on east part of floor	100	2·9
n	A very small crater N.W. of *m*	80	2·5
α	A mountain on east wall of Ptolemæus	100	3·6
β			
γ	A peak on north-east wall, 6,000 feet high	60	2·7
δ	A peak N. of γ	60	3·1
ε	A peak on the S. wall of the pass into *Alphonsus*	140	2·5
η	A peak on N.W. wall, 8,671 feet high	300	1·2
λ	A peak on N.E. wall, 4,000 feet high	80	3·3
μ	A peak on N. wall, 4,000 feet high	50	2·3
φ	A crater-row or rill, close under the west of α	100	3·5

THE PLANETS FOR AUGUST.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	7 55 35	N.21 27	5″·6	23 11·8
	9th	9 3 4	N.18 30½	5″·0	23 47·7
	17th	9 59 27	N.14 8½	5″·0	0 16·4
	25th	10 56 13	N. 8 12½	5″·0	0 41·5
Venus ...	1st	11 20 27	N. 5 13	15″·0	2 40·1
	9th	11 53 36	N. 1 10	15″·6	2 41·6
	17th	12 26 9	S. 2 56	16″·8	2 42·7
	25th	12 58 20	S. 6 58½	18″·0	2 43·3
Jupiter ...	17th	5 41 16	N.22 54	33″·4	19 55·0
	27th	5 48 4	N.22 57	34″·2	19 22·4
Saturn ...	1st	3 32 48	N.16 54½	16″·0	18 49·7
	9th	3 14 39	N.16 59½	16″·2	8 20·1
	17th	3 36 4	N.17 2½	16″·4	17 50·1
	25th	3 37 3	N.17 4½	16″·6	17 19·6

Mercury rises about an hour and a quarter before the sun on the 1st, the interval decreasing. From the middle of the month he sets after the sun.

Venus sets nearly an hour and a half after the sun at the beginning of the month, the interval decreasing.

Jupiter rises about half an hour after midnight on the 1st, and then earlier each night.

Saturn rises about half an hour before midnight on the 1st, the interval increasing.

ASTRONOMICAL OCCURRENCES FOR AUGUST, 1882.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
Tues	1	 23	Sidereal Time at Mean Noon 8h. 39m. 58·19s. Conjunction of Mars and Venus 0° 5′ N.	2nd Ec. D. 1st Ec. D.	13 35 28 14 29 30	α Cygni. — 11 55·5
Wed	2	8 51 9 55 10 49	Occultation reappearance of B.A.C. 8276 (6½) Occultation of 22 Piscium (6) Reappearance of ditto	1st Tr. I. 1st Sh. E. 1st Tr. E.	12 41 13 55 14 55	11 51·6
Thur	3		Sun's Meridian Passage 5m. 56·07s. after Mean Noon	2nd Tr. E. 3rd Tr. E.	13 2 14 0	11 47·7
Fri	4					11 43·7
Sat	5	16 13	☾ Moon's Last Quarter			11 39·8
Sun	6	14	Conjunction of Moon and Saturn 2° 19′ S.			11 35·9
Mon	7					11 31·9
Tues	8	13 19 14 13 18	Occultation of B.A.C. 1733 (6½) Reappearance of ditto Conjunction of Moon and Jupiter 1° 51′ N.	2nd Ec. D. 1st Ec. D.	16 12 35 16 23 4	11 28·0
Wed	9			1st Sh. I. 1st Tr. I. 1st Sh. E.	13 35 14 40 15 49	11 24·1
Thur	10			2nd Sh. E. 3rd Sh. E. 1st Oc. R.	13 31 13 50 14 9	11 20·1
Fri	11	3	Neptune at quadrature with the Sun			11 16·2
Sat	12		Saturn's Ring: Major axis=40″·76 Minor axis=16″·39			11 12·3
Sun	13	9 10 12	● New Moon Conjunction of Moon and Mercury 7° 6′ N.			11 8·3
Mon	14	12	Superior conjunction of Mercury and Sun			11 4·4
Tues	15		Illuminated portion of disc of Venus=0·674 Illuminated portion of disc of Mars=0·966			11 0·5
Wed	16	18	Conjunction of Moon and Mars 5° 4′ N. Sidereal Time at Mean Noon 9h. 39m. 6·51s.	1st Sh. I. 1st Tr. I.	15 29 16 38	10 56·5

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. α Cygni.
Thur	17	10	Conjunction of Moon and Venus 3° 48′ N.	2nd Sh I. 3rd Sh. I. 2nd Tr. I.	13 27 15 32 15 47	— 10 52·6
Fri	18	10	Saturn at quadrature with the Sun	1st Sh. E. 1st Tr. E.	12 12 13 23	10 48·7
Sat	19		Sun's Meridian Passage 3m. 26·58s. after Mean Noon	2nd Oc. R.	13 14	10 44·7
Sun	20					10 40·8
Mon	21	12 54	☽ Moon's First Quarter	3rd Oc. R.	12 39	10 36·9
Tues	22					10 32·9
Wed	23	10 50 11 39	Occultation of B.A.C. 5954 (6) Reappearance of ditto			10 29·0
Thur	24			1st Ec. D. 2nd Sh. I.	14 38 23 15 58	10 25·1
Fri	25	6 46	Near approach of B.A.C. 6658 (6)	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	11 52 13 5 14 6 15 20	10 21·1
Sat	26			1st Oc. R. 2nd Oc. R.	12 33 15 58	10 17·2
Sun	27	16 7	Occultation of e^1 Capricorni (4½)			10 13·3
Mon	28	9 18 13 26 14 30	○ Full Moon Occultation of κ Aquarii (5) Reappearance of ditto Conjunction of Uranus and Mercury 0° 18′ N.	3rd Ec. R. 3rd Oc. D. 3rd Oc. R.	11 37 46 14 23 16 53	10 9·3
Tues	29	7 55 13 30 14 37 7 21	Near approach of B.A.C. 8152 (6½) Occultation of 15 Piscium (6½) Reappearance of ditto Near approach of λ Piscium (5)			10 5·4
Wed	30	13 56 14 13	Occultation of 51 Piscium (6) Reappearance of ditto			10 1·5
Thur	31			1st Ec. D.	16 31 48	9 57·5
SEPT. Fri	1		Saturn's Ring: Major axis=42″·27 Minor axis=17″·03	1st Sh. I. 1st Tr. I. 1st Sh. E.	13 46 15 2 16 0	9 53·6

A COMET.

Captain W. Gillies, of the Royal Mail steamship *Neva*, writes to the *Buenos Ayres Standard* that on the 19th of June, in lat. 28° 48′ S., long. 48° 17′ W., he observed a comet bearing N. 60° W. (true), ten degrees above the horizon, tail extending towards the zenith, about five degrees long.

Books received.—British Rainfall, 1881. By G. J. Symons, London: E. Stanford, Charing Cross.—Meteorological Observations made at the Adelaide Observatory during the year, 1879.—Introduction to Greenwich Astronomical Observations, 1880.—Greenwich Astronomical Results, 1880.—Observations des Comètes *b* et *c* de 1881. Par M. F. Terby, Louvain, 1881.—Studies of Venus-Transits. By R. A. Proctor. London, Longmans, Green and Co. 1882.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Dec., 1881.
Markwick, E. E.
Yeates & Sons.
Yeates, Miss.

To March, 1882.
Corbett, C. J.
Jackson-Gwilt, Mrs. H.

To June, 1882.
Gore, J. E.
Guyon, Capt.
London Institution.

To Aug., 1882.
Esdaile, J. R.

To Dec., 1882.
Erck, Dr. J. W.
Rylands, T. G.

To March, 1883.
Locke, W.

To June, 1883.
Gooch, Miss.
Tebbutt, J.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON. 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

The Astronomical Register.

No. 237. SEPTEMBER. 1882.

NOTES ON AN ANCIENT CHINESE CALENDAR.

By E. B. KNOBEL, Hon. Sec. Royal Astronomical Society.

The meagre and imperfect knowledge we possess of ancient Chinese astronomy leads us to attach value and interest to any further information on the subject that may be brought to light.

Chinese astronomy has been investigated and examined in a searching manner by many competent oriental scholars and astronomers; and no labour has been spared in the endeavour to either prove or refute the great antiquity claimed for it, and the alleged high character of the scientific work of the ancient Chinese. Prominent among those who have supported the view of the ancient Chinese astronomers being of an advanced order of intelligence is the late M. J. B. Biot, whose researches on the subject are of great value, though his deductions are difficult to accept. M. Biot does not hesitate to intimate that the Chinese at an earlier period than B.C. 2357 were in the habit of particularly observing the circumpolar stars, of noting their transits across the meridian, and of comparing therewith the transits of other stars; but unfortunately the evidence is wanting to support these important statements. Such, and similar high claims for the Chinese, have been investigated and refuted by the labours of Prof. A. Weber, of Berlin, Prof. W. D. Whitney, M. L. A. Sedillot and other philologists, though Mr. Williams states in his "Chinese Observations of Comets" that "at a period long anterior to the commencement of civilization among the western nations . . . astronomy had been carried to a great degree of perfection by

the Chinese, as manifested by their still existing records, whose authenticity is not only strongly asserted by that people, but is acknowledged by some of the most eminent European scholars of the present day." More recently the extensive and valuable "Uranographie Chinoise" of Prof. Gustave Schlegel has appeared, which claims to prove, with more or less plausibility, that astronomy emanated originally from China and was thence derived by western nations.

This work must always be considered classic, and it is of great value in any enquiry on the subject. But where so little of reliable accurate observation has been remitted to us, it follows that unsupported speculation must enter freely into the discussion which appears to be dependent more on philological than on astronomical evidence.

Professor R. K. Douglas, of the British Museum, has recently published in "Orientalia Antiqua"* a translation, accompanied by notes, of the original text of "The Calendar of the Hea Dynasty." It appears that the Hea Dynasty ruled over a portion of Central and Southern China, from B.C. 2205 to B.C. 1766; very little is however known of this period, and the only apparently reliable information available seems to be the above calendar.

The original text is said to have passed through the hands of Confucius, and the few editions which have been handed down seem to have been slightly altered by their several editors. The copy translated by Prof. Douglas is contained in the Library of the British Museum, and has no claim to antiquity. The Calendar consists of a list, in the order of the months, of rural, agricultural, and technical operations, accompanied by some astronomical remarks and observations to fix the season of the year. The astronomical notes cannot fail to be considered of importance, though of a vague and indefinite character, as they contain some remarks which tend to support the view of the great antiquity of the calendar.

As the calendar is arranged in order of the months, it is necessary to enquire when the Chinese year at this epoch began. Prof. Douglas states that "during the Hea Dynasty the year began, as it does at the present time, with the third month of the solar year, that is to say, with the beginning of the third month after the winter solstice, or in other words any time that the moon might decide between about the middle of January and the end of February." In explanation of this we learn from

* "Orientalia Antiqua; or, Documents and Researches relating to the History of the Writings, Languages, and Arts of the East." Edited by Terrien de La Couperie, M.R.A.S. Vol. I., Part I. London, 1882.

Du Halde that Yao, who invented the Chinese civil year B.C. 2317, made it luni-solar, and to begin from the instant of that new moon which happens nearest to the time when the sun enters the 15° of Aquarius. This on the average would be about the fourth or fifth day of February, and this was called the beginning of spring.

The following quotations from the *First Month* of the calendar seem to show that as the astronomical event marking the commencement of the year was necessarily difficult to ascertain, so a series of natural history and agricultural observations are given to indicate the special season.

"In the first month come forth the hybernating insects.

"The wild geese go to their northern homes.

"Pheasants drum with their wings and call.

"The agriculturist binds together his plough.

"In the enclosed gardens are seen the leeks.

"At this season there are high winds.

"The beginning of service in the public fields.

"Is picked the rue.

"Chrysanthemums then are seen," &c., &c.*

The following are the astronomical allusions in the calendar upon which I have commented *seriatim* :—

First Month (February).

"At early dusk TSAN (the constellation Orion) is central."

At the beginning of February the sun's R.A. = 21h. At B.C. 2000 the R.A. of the central portion of Orion was about 2h. 20m., or, following the sun, 5h. 20m. in R.A. In China at 35° north latitude, the sun set about 5h. 12m., consequently shortly after that time Orion was on the meridian, or "central," and the statement for the alleged antiquity seems to be correct within wide limits. It may be remarked that the R.A. of Orion 2000 years later would have increased 1h. 44m.

"TEOU PING (the Handle of the Measure, *i.e.*, the tail of the Great Bear) hangs downwards."

The time is not mentioned, and the statement (assumed for

---

* "The Chinese almanac, like many others of the kind in Europe, contains predictions and advice for every day in the year. In their first month, which is about our February, the ice is said to melt, the wild fowl to fly northward, and the foliage of trees and plants to be renewed; in the second, peach-trees blossom, swallows return, and there is much thunder and lightning; in the sixth, the weather grows hot, and the period of heavy rains comes on; in the ninth, wild fowl return to the south, the chrysanthemum flowers, trees turn yellow and shed their foliage; in the twelfth, lakes and rivers are covered with ice, and the ground is frozen."—"Davis's Chinese," Vol. III., p. 77.

early dusk) can only be correct within very wide limits. The position of the stars of the Great Bear has been employed in all ages as an indication of the season of the year or the hour of night. Schlegel says that the Chinese astrologers state that "the determining of the four seasons and fixing all periods depend upon the Great Bear."

Third Month (April).

"In the third month TSAN (Orion) is then hidden."

In April the sun's R.A. varies from 1h. to 2h. 30m. R.A. of Orion B.C. 2000 = 2h. 20m., therefore the vague statement for the alleged epoch would be correct.

Fourth Month (May).

"In the fourth month MAO (the Pleiades) are then seen."

The sun's R.A. at the beginning of this month is about 3h. Pleiades R.A. B.C. 2000 = about 0h. 14m. The sun would rise in China about 5 a.m., and stars would be visible less than two hours before this, therefore the statement is fairly correct.

The Chinese name for the Pleiades—MAO—is very suggestive of a common origin with names for that cluster used by other nations. For instance, it is stated that* "*Maia* (the mother of Mercury) is the Pleias or the cluster of stars known even, by the vulgar, and placed on the back of the Bull. The Eastern (Hebrew) nations called these stars *Mæah*, which signifies 'the hundred,' 'the multitude.'" The Arabic word Mâyât, "a hundred," is similar. The heliacal rising of the Pleiades is one of the earliest recorded astronomical facts among Greek writers. At the time of Hesiod, B.C. 900, the heliacal rising of the Pleiades was about the beginning of May. The Pleiades was called "the constellation of navigation," because the navigation of the Mediterranean lasted from May to November—from its rising to its setting. It is admitted that the name of our month "May" is derived from "Maia," probably from the important significance of the rising of Maia, the Pleiades, at this season at a remote period. It therefore comes very forcibly upon us that the Chinese Mao, the Greek Maia, the Hebrew Mæah, and the Arabic Mâyât (though I have not found this last word used astronomically) have a common origin. We know the word was used in Greece 1000 years B.C., but we have nothing really *authentic* to prove the antiquity of the word in Chinese astronomy. Schlegel says that the asterism Mao is one of the most important in the Chinese sphere, as it furnishes the most unexceptionable proof of its primitive position, setting

* "History of the Heavens." By the Abbé Pluche, Translation, London. 1752.

on the day of the autumnal equinox. If our suggestion is correct, we can only conclude that the word was derived by the Chinese from the west, as they are alleged by Sedillot and others to have derived a great deal of their astronomy.

"At early dusk NAN-MUN (α Centauri) is exactly south."

The R.A. of α Centauri B.C. 2000 was about 10h. 30m. or $7\frac{1}{2}$h., following the sun in R.A. The sun set at about 6h. 40m. The statement is fairly correct. It must be borne in mind that at B.C. 2000 α Centauri had 20° less south declination than it has now.

Fifth Month (June).

"In the fifth month TSAN (Orion) then is seen."

About the beginning of the month the sun's R.A. is 5h. Orion R.A. at B.C. 2000 = 2h. 20m. The sun would rise in China in latitude 35°, about 4h. 50m., and stars could be seen less than two hours before this, therefore the statement is fairly correct for Orion being visible at dawn.

"At early dusk TA-HO (Antares) is central."

B.C. 2000 the R.A. of α Scorpii = 12h. 46m., and it was on the meridian at 7h. 45m. p.m., and as the sun set in China at latitude 35° at 7h. 8m., the statement is approximately correct.

Sixth Month (July).

"In the 6th month at early dusk TEOU PING (the tail of the Great Bear) is exactly upwards."

One can only suppose this means when the tail is pointing to the south. Schlegel states that Ho-koan-tsse, who wrote B.C. 400, says that "when in the evening the tail of the Great Bear points to the east it is spring throughout the world; when to the south, it is summer; when to the west, it is autumn; and when to the north, it is winter.

Seventh Month (August).

"At early dusk TCHI-NIU, 'The Weaving Woman' (*i.e.*, α Lyræ), is exactly in its eastern home."

This is very difficult to understand, and it is perhaps a corrupted passage. The Chinese commentators on this calendar say that "in the seventh month the sun is in the constellation KANG, and TCHI-NIU in TEOU," which is a constellation or domicile in the ecliptic about 90° to the east of KANG. It may be conjectured that as in this month the longitude of TCHI-NIU was 90° to the east of the sun that a clue to the meaning may be thus afforded.

"TEOU PING (the tail of the Great Bear) hangs downwards, and it is then dawn."

In the first month we had a similar remark, which we assumed

for the evening. As therefore the latter statement is for six months and twelve hours after the former it is of course approximately correct.

Eighth Month (September).

"CHIN then is hidden."

There appear to be several applications of the word "Chin." Schlegel considers the word as of similar import to the Egyptian "Horus"—the emblem of labour—a symbol or figurative representation of important periods in the rural year. "Chin" was used to designate all celestial bodies whose appearance indicated a particular time or season. "Chin" signifies the planet Mercury, and this interpretation we shall consider in a further reference under the ninth month. "Chin" also signifies the constellation Scorpio. The ancient Chinese character for the word consisted of the combination of three hieroglyphics: one representing an overhanging precipice, the second the sign for the earth, and the third signifying two men. The two men are supposed to be on the earth, taking shelter under a rock from a shower. As showers of rain after the winter are an indication of the return of heat, and as at this period the heliacal rising of the constellation Scorpio was coincident with such season, it therefore was called "Chin," as marking the special season. (This word must not be confounded with the similarly spelt name of the 28th Chinese asterism, the "determinant" of which is β Corvi, as the Chinese characters are very dissimilar.) On this view, as the R.A. of α Scorpii at the supposed epoch B.C. 2000 was 12h. 47m., the statement is correct, for the constellation would be very close to the sun.

"TSAN (Orion) is central and it is then dawn."

The R.A. of Orion B.C. 2000 was 2h. 20m., or about $8\frac{1}{2}$ to 9 hours in R.A. in advance of the sun, it would therefore be on the meridian about dawn.

Ninth Month (October).

"CHIN is in conjunction with the sun."

It is possible that here the word "Chin" signifies Mercury. The Chinese named Mercury "Chin-Sing, the Planet of the Hour," and for the following reasons. The opinion of the ancient Chinese was that the motion of Mercury was regular; each day it advanced one degree, and each month one sign, so that it completed a revolution round the earth in one year. (Three times the synodic period of Mercury $= 347{\cdot}64$ days.) It is always visible at the vernal and autumnal equinoxes, and at the summer and winter solstices, and during the rest of the year it is hidden in the rays of the sun, and thus it marked the seasons by its four

apparitions. This is rather adverse to the alleged accuracy of the ancient Chinese.

As according to this view Chin (Mercury) would be invisible in October, the quotation, "Chin is in conjunction with the sun," would apply to the planet; but if "Chin" here means the constellation Scorpio, as we have presumed in the first reference to it, then the Right Ascension of the sun being about 12h. 45m. for the first week in October and that of α Scorpii at B.C. 2000, 12h. 46m., the statement would be correct for the epoch, and this perhaps is the more probable interpretation.

Tenth Month (November).

"At early dusk NAN-MUN (α Centauri) is seen."

As at B.C. 2000 α Centauri would be 4h. in Right Ascension in advance of the sun, the statement is clearly erroneous.

"TCHI-NIU, 'the Weaving Woman' (α Lyræ), is exactly in its northern home, and it is then dawn."

Three months before this, Tchi-niu was stated to be in its eastern home, and its longitude was about 90° to the east of the sun. In the tenth month, however, it had about the same longitude as the sun. The statement is quite inexplicable.

The calendar contains no further astronomical allusions. The few quotations which have been discussed can only be considered as vaguely confirmatory of the alleged antiquity.* It would be out of place here to refer to the philological and other reasons adduced by Prof. Douglas to that end, which make his work so valuable and interesting a contribution to our knowledge of the early Chinese.

OBSERVATORIES OF EUROPE.†

In the latter part of 1880, the generosity of M. Bischoffsheim, the well-known founder of the observatory at Nice, enabled M. Perrotin to visit many of the observatories of Europe. Provided also with letters of introduction by M. Faye, President of the Bureau des Longitudes, in the name of that learned body, he met everywhere with a friendly, often a warm reception, and many marks of sympathy. We purpose to extract from his interesting volume some particulars of the establishments he

* "Les phénomènes célestes qui se trouvent dans les anciennes astronomies Chinoises et dans leurs autres livres, n'y sont point mises sur de véritables observations faites au tems même de ces phénomènes, mais par des calculs faits après coup."—Souciet, Obs. Mat., Paris, 1729, p. 6.

† *Visite à divers Observatoires d'Europe—Notes de Voyage.* Par M. J. Perrotin, Directeur de l'Observatoire de Nice. Paris: Gauthier-Villars, Quai des Augustins, 55. 1881. pp. iv. 150.

visited, greatly, however, abridging his copious account of their instruments. The different observatories follow in the order in which they were visited.

STRASBURG. Until the completion of the new observatory of the university, M. Winnecke is provisionally established in the buildings of the old Faculté des Sciences. He has a meridian telescope 4-in. aperture, by Cauchoix, a comet-seeker, and various instruments which were employed in the observation of the transit of Venus. The meridian telescope is used for finding the time, and for lunar and planetary observations. The comet-seeker, mounted by Repsold, with its movement in azimuth, enables the heavens to be swept along parallels to the horizon, which facilitates researches of the regions nearest to the sun, thus increasing the chances of discovery of comets, several of which have been found by its means. The situation of the other instruments, *i.e.*, two heliometers, an equatorial, and another telescope, is unfavourable; yet, notwithstanding, M. Winnecke and his assistants, MM. Schur and Hartwig have carried out many and important labours, amongst which may be mentioned—measurements of the diameters of the sun and planets, of the Pleiades; observations of the satellites of Jupiter, the tables of which M. Schur purposes to reconstruct, and of the libration of the moon. M. Winnecke is more particularly devoted to nebulæ, of which he has determined the positions of over 500, comparing them usually with very near stars. He has used an equatorial of 6-in., with clockwork mounting by M. M. Repsold. The activity hitherto displayed with comparatively feeble means shows what this observatory will become in the future, when its *personnel*, directed by one of the most distinguished astronomers of Germany, shall be in possession of new instruments, constructed with all modern optical and mechanical improvements, and for which no sacrifice has been spared.

The new observatory commands a fine view, uninterrupted in every direction, extending eastward to the Black Forest, and westward to the chain of the Vosges. It consists of three isolated buildings, two for the instruments and the third for dwellings, united by galleries abutting on a central point. Owing to the marshy state of the soil, which often occasions mists at night sometimes rising to six feet, the floor of the meridian halls is raised about 16 feet. In one of the halls will be placed a new meridian circle by M. M. Repsold, with every precaution for maintaining a constant or nearly constant temperature. In the other hall is to be located the meridian telescope of Cauchoix, to be used chiefly for the instruction of students, and a small portable circle will be near it. On the western part of the same

building, two towers with spherical domes will contain, the one to the south the equatorial of 6-in., that on the north an altazimuth of recent make. The metallic parts of the domes are carefully connected with a lightning conductor; there is a supply of water for days of excessive heat; and terraces enable a person to go all round them. The second building on the N.W. is a large square structure, from the interior of which rises a tower surmounted by a dome intended to receive an equatorial of 18-in. aperture. The other spaces are devoted to a large entrance-hall, the standard clock, the library, a study, and a hall for the courses. A circular railway on the exterior terrace of the dome is intended to be used with the comet-seeker.

The new instruments, the meridian-circle, the equatorial, and the altazimuth, have been furnished by M. M. Repsold, conformably in many details of their construction to the ideas of M. Winnecke. The telescope of the meridian-circle is 6-in. aperture, the objective and the eye-piece can change places, the surest mode of getting rid of the effects of flexure. For the study of the pivots and the variations of inclination of the axis there is an objective in one pivot and a fixed point in the other, which is viewed by collimators E. and W. There are two graduated circles about 2-ft. 3-in. diameter, read by eight microscopes. M. Winnecke has placed meridian marks N. and S. 500 feet from the instrument, which will be viewed with a small lens placed before the eye-piece and movable by a button. The altazimuth is one of the largest instruments of the kind. The telescope, 5-in. aperture and 5-ft. focal length, is placed at the extremity of the horizontal axis. The circles are 24-in. diameter, the horizontal read by four microscopes, the vertical by two. A movable bath of mercury enables observations of the nadir to be made in different azimuths, and two marks N. and S. are placed at distances of 500 feet. This altazimuth can be used for all the purposes of a prime vertical instrument, for lunar work, for the small planets and neighbouring stars, in view of the determination of parallax, and for cometary observations. M. Winnecke thinks of employing it more especially for the measurement of declination of circumpolar stars, by azimuthal observations of their greatest elongations in the two positions of the instrument. The effect of refraction will thus be eliminated, and it will be interesting to compare the results with those obtained by direct meridional observations. The great equatorial, 18-in. aperture, differs little from the arrangements of the Pulkova 14-in., the mounting of which has quite recently been renovated, and which we shall speak of in connection with Hamburgh.

Munich. The observatory of Munich has been without a

director since the death of Lamont; it is provisionally entrusted to the superintendence of M. Seidel, professor in the university. There is a meridian-circle by Reichenbach, 3·9-in. aperture, with which Lamont observed his zones of stars. Besides, there is a meridian telescope of rather larger size than the preceding, an altazimuth, a horizontal circle, and two vertical circles having a horizontal telescope, and lastly, a heliometer by Fraunhofer. In a separate pavilion is an equatorial of 10½-in. and 15-ft. focal distance, by Merz, which is at present unmounted. Colonel Orft, of the Bavarian état-major, at the instigation of M. d'Abbadie, studies at the observatory the variation of the vertical, and M. Feldkirchner makes regular daily magnetic observations. We have seen at M. Merz's two objectives of 14-in. and one of 18-in. destined for the observatory of Milan. M. Steinheil showed us all the minute details of his workshops; the preliminary experiments for ascertaining the purity and homogeneity of the glass, and the methods based upon the principle of coloured rings, adapted to verify the sphericity of the surfaces by comparison with auxiliary glasses. He also let us witness the mechanical polishing of a number of glasses in course of execution, and the work of which, more or less advanced, exhibits the series of intermediate operations through which a single glass must successively pass. Steinheil's objectives have all their surfaces rigorously spherical. In addition to the ordinary objectives are to be found here astronomical objectives, formed of three lenses connected together, a crown glass between the flint glasses, the aperture of which is one-fourth of the focal distance; eye-pieces also composed of three lenses cemented into one piece; objectives with three lenses apart, allowing of the correction of the distant colours; aplanatic lenses with large field, and without distortion, spherical or chromatic aberration; also objectives for photography. M. A. Dietz, successor of Ertel, makes especially instruments for geodesy, and has besides furnished various transit instruments and a meridian-circle for several private observatories.

VIENNA. The observatory is situated on the N.W. of the city, in the village of Währing, on a height called Türkenschanze. Begun in 1874, after the plans and under the direction of Karl von Littrow, it was finished in 1880 under the direction of his successor, M. Ed. Weiss, by the architects Fellner and Helmer. This establishment is one of the finest and largest in Europe. It is a single mass of building in form of a cross, having the axis N. and S.; the wings E. and W. and the N. part constitute the observatory; the S. part consists of the dwellings, the bureaux and the library. At the N.E. and W. extremities are three domes intended for various instruments. Between the towers

on which they rest, and the central tower of the great equatorial, there are three large halls for the meridian instruments and a prime vertical. The great dome is 46 feet in diameter, the others 26 feet. All are spherical. The pillars of the instruments are of enormously massive masonry, strengthened by strong piers.

The instruments at present in the observatory are the following: in the meridian hall to the W. is a meridian-circle with a Fraunhofer objective of 4·3-in. aperture; two pillars N. and S. are set up as collimators, and the instrument is reversible. In the N. hall is a transit instrument with an objective by Fraunhofer, 4·7-in. aperture, which serves the purpose of a prime vertical instrument. In both these telescopes a system of lenses is designed to prevent the flexure of the tube. In the E. tower an equatorial without clockwork with a Fraunhofer objective of 6·3-in. aperture serves for the observation of the small planets and of comets, it was the principal instrument of the old observatory. In the W. tower is an equatorial recently made by Alvan Clark, with a telescope 11·8-in. aperture and 10-ft. focal length, with clockwork movement and micrometer. The observing steps are similar to those of the Harvard College equatorial. In the eastern meridian hall, which contains a great number of small instruments that belónged to the old observatory, there will be placed by-and-by a large meridian-circle. The great dome will shortly receive an equatorial by Grubb, 26-in. aperture, and about 33-ft. focal length, to which we shall return in the account of our visit to the workshops of its constructor in Dublin. We may add that M. Weiss will have an excellent associate in M. Palisa, the well-known director of the observatory of Pola, which henceforth will form part of the observatory of Vienna.

Besides its official observatory, Vienna possesses a small observatory which M. Oppolzer erected above his dwelling-house at Josephstadt, that contains a 5-in. equatorial by Merz, with a ring micrometer, its tube is of wood, and there is no clockwork. With this the brother of M. Palisa has made numerous observations. There is also a meridian-circle, 4-in. aperture. M. Oppolzer has the direction of the work of the measure of degrees (*Gradmessung*), and is at present employed in the reduction of 42 determinations of longitude, undertaken under his direction. There is a magnetic and meteorological observatory at Vienna, presided over by M. Hann, very richly furnished with instruments. M. Hann is charged with the discussion of the observations of 250 meteorological stations under his direction. Of 16 of these complete observations are regularly published, and of the rest only the general results.

LEIPZIG. The observatory possesses a meridian-circle of Pistor and Martins, 6-in. aperture, with two graduated circles; in construction it is identical with the one at Berlin by the same makers, and is reversible. Two collimators are placed N. and S. A bath of mercury is in a fixed position for the nadir, and another serves for observation by reflection. A study of the errors of division shows that the mean of the reading of the four microscopes has to be corrected by a quantity less than $0''\cdot5$. This instrument is employed for regular observations of the large planets; and besides MM. Bruhns, Weineck, and Leppig observe Argelander's zone from $+5^\circ$ to $+10^\circ$ Decl. An equatorial of 8-in. by Steinheil, is employed by Dr. Peters for the observation of the small planets and comets. A level which can be placed on the declination axis allows of observations by Hansen's method. There is likewise a telescope placed in the prime vertical for the use of the students of the university; an equatorial of 4-in. by Repsold (used in the transit of Venus), with which Dr. Hilfiker makes measurements of nebulæ; a comet-seeker under the same dome, and other instruments of less importance. The observatory has a meteorological department, in which six daily observations are regularly made. M. Bruhns is chief of the meteorological service in Saxony, which comprises 20 stations.

POTSDAM. The observatory of physical astronomy at Potsdam is situated on the north of the city, on an elevation which commands a vast plain covered with forests. It is directed by a commission composed of MM. Kirchhoff, Förster, and Auwers. It consists of two buildings, one of which, oriented east and west, is surmounted by three domes united by two galleries; the other on the north, at right angles to the former, and joined to it, contains the halls of spectroscopy, photography, and the studies of the astronomers. The dwelling-houses are on the N.E. In the same direction, but lower down, in an isolated building, are gas works and the machines moved by steam which serve to draw water from a well 150 feet deep, and to raise it afterwards to a reservoir above the observatory for the various uses of the establishment. Two men are exclusively occupied about the works and the engines. The central dome contains an equatorial which rests on a vault isolated from the rest of the edifice. The other two have each an equatorial on a pillar of masonry. There is communication between the three domes and the tower, also by a terrace covered with turf. The domes are of an oval form; the greatest, which is in the middle, is 33 feet, the other two 23 feet in diameter. The covering is double, of sheet iron and wood, the latter inside. The dome rolls on a system of rollers like those of the domes of the observatory of Vienna, and by the aid of mechanism

exactly similar. The width of the opening is four feet in the large dome, and three feet in the other two, and they extend the whole length of a meridian. A contrivance has been devised by which, for observing the sun, the openings can be made of different dimensions, and placed at different heights.

In the large dome is an equatorial of 12-in. and nearly 18-ft. focal length, with clockwork and micrometer; the mechanical part by Repsold, the optical part by Schröder. The stand is a hollow column of cast-iron, and the tube is of wood. The seat of the observer is an ordinary flight of steps without railway. In a recess of the wall is a box to serve as a table, the higher and inclined part of which is made of a plate of roughened glass illumined by a gas burner underneath, by which it is possible to write or sketch without any other light. Another gas burner concealed behind a board above the table enables, on occasion, light to be thrown on the upper part of the table. In the western tower is an equatorial of $7\frac{1}{2}$-in. by Grubb, with clockwork. M. Spörer makes with it regular observations of the spots of the sun, by projecting the image on a divided scale; and with a galvanometer constructed for the purpose, he studies the difference of temperature of the spots, and that of the surface of the sun. In the eastern dome a 5-in. equatorial provided with a spectroscope is employed by MM. Spörer and Kempf in the observation of protuberances; in the same hall is a photometer of Zöllner, with which M. Möller studies the brilliancy of the stars. On the ground floor in the study of M. Vogel we see a spectroscope with six prisms of Rutherford, which he used in his great work on the solar spectrum; an instrument for measuring indices of refraction, another which serves for the comparison of the intensity of light of different portions of any spectrum with the corresponding regions of a particular flame, which here is a petroleum flame. Lastly, a stellar spectroscope with one prism, made by Hilger, of London.

In the subterranean quarters there is a Gramme machine of six-horse power, moved by a gas engine, and adjoining are the rooms for the machinist and the carpenter. In the well, of which we have spoken, a certain number of thermometers are placed at various distances, some against the wall, others in the ground, which give the temperatures at different depths. About halfway down a room has been constructed for experiments requiring an invariable temperature; and a special arrangement permits of advantage being taken of the great depth of the well in the event of its being desired to make experiments with the pendulum.

(*To be continued.*)

REVIEWS.

1. *On the Longitude of the Sydney Observatory.*
2. *On the Orbit-elements of Comet I.* 1880. (Great Southern Comet).
3. *Note on the Opposition Magnitudes of Uranus and Jupiter.* By John Tebbutt, F.R.A.S.

These are memoirs read before the Royal Society of N. S. W. in 1880. 1. 23 lunar occultations gave for the longitude of the Sydney observatory, 10h. 4m. 50·64. Mr. Russell obtained from moon culminations in five years 10h. 4m. 50·81 sec. And by the telegraphic difference of longitude between the Melbourne observatory and Sydney there results 1h. 4m. 50·57sec. The agreement between the three results, as Mr. Tebbutt observes, is remarkably close, and he thinks that no more satisfactory result is likely to be obtained from a consideration of the moon's motions alone; but he awaits with interest the confirmation of their accuracy by telegraphic communication with Europe.

2. Interesting information is collected regarding Comet I., 1880. "One of the grandest of modern times," and the different orbits that have been calculated for it. Mr. Tebbutt found his own closely similar to the elements computed by Hubbard for the great Comet of 1843; and to the third orbit of Laugier and Mauvais for the same, who assigned a period of 35 years. He found that at its perihelion passage the centre of the Comet I. 1880 was only 190,480 miles from the sun's surface, and the heat to which it was subjected must have been something beyond human conception, and the sun itself subtended an angle of 88°, or 165 times greater than its apparent diameter as seen from the earth. It also appears that the Comet was only *three hours* on the north side of the plane of the earth's orbit, and in this brief space of time it described an arc of 180°, or just one-half of its apparent path in the heavens as seen from the sun. "Assuming" says Mr. Tebbutt, "that our late visitor is the great Comet of 1843 with a period of 37 years, it will ultimately reach its aphelion at a distance of 2,052 millions of miles, or within the orbit of the planet Neptune, and will . . . make its appearance to the earth's inhabitants about the year 1,917."

3. Mr. Tebbutt had pointed out the gradual increase of the brightness of Uranus at each successive opposition, which increase will go on till the opposition of 1882, after which the planet's brightness will diminish. He finds that at the opposition of 1880 it might be safely recorded as a star of 5½ magnitude.

Can the air be at rest while it is in motion? A question proposed by John B. T. New York. 1880. pp. 62.

This was written in 1864, so that we suppose the writer must have hitherto failed to find a satisfactory solution of his difficulties about the rotation of the earth. We have not space, time, or disposition to discuss them. The pamphlet passes by the solid proofs, terrestrial and celestial, of the rotation of the earth, and is mostly occupied with certain atmospheric phenomena which the writer finds irreconcilable with that rotation. Some minds seem incapable of a broad and fundamental study of a subject, and fix themselves exclusively on some points whether of real or imaginary difficulty. The former may be trivial in comparison with counter-evidence, but in this case, it seems to us, that fuller information would show John B. T. that his difficulties are of the latter class.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expresse by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

SKETCHES OF JUPITER.

In cases where it is intended to delineate the whole of this planet's surface, it is very necessary that the sketches extend over as short a period as possible. The markings should be observed as they successively come into view, during the greater part of two or three successive nights, and their different aspects drawn at brief intervals. It is becoming the custom to make a series of sketches extend over several months, or even one whole opposition, and to arrange them regularly, according to progressive differences of longitude, the idea being that all the principal features of the planet will thus be presented and enable other observers, who may have drawings obtained under corresponding longitudes, to make fair comparisons. But this plan not only fails to show all the features of the planet, but renders the comparison of drawings not permissible, because the markings are presented under a great variety of motions. It must be remembered that Mr. Marth's adopted rotation period of 9h. 55m. 34·47s. (= 870°·42 daily motion) is derived from one object only, viz., the red spot, and that this moves slower than many other features. The rotation of the brilliant spot is 9h. 50m. 6·8s. (or 878°·48 daily), while that of a series of dark spots visible on a belt N. of the equator in the autumn of 1880 was even swifter than this, 9h. 48m. 9s. (881°·40 daily), as severally derived by Mr. Marth. Some other markings give anomalous periods, and there is no doubt that the chief features of this planet are influenced by a remarkable difference of velocities, which has the effect of displacing their relative positions in very short intervals of time.

For instance, a sketch of Jupiter made on Dec. 24, 1881, at 9h. 43m., when the longitude was 20°·7, shows both the red and the bright spots crossing the central meridian. Another sketch made ten days later, on Jan. 3, 1882, at 7h. 57m., when the longitude was the same, shows the red spot about central, but the bright spot is nowhere visible because it must then have been on the extreme W. margin of the disc. In fact, the longitude of the latter object had altered some 81° in the ten days, and the other features near the equator had participated in this

rapid drifting to the westwards; so that, comparing the two drawings, there is no identity whatever in the configuration of the objects on the equator at the two epochs, nor indeed could any have been expected, because the features have all been relatively displaced in the interim by the effects of their different velocities. At periods of $22\frac{1}{4}$ days the longitude of the bright spot (computed on the diurnal rate of $870^{\circ}\cdot42$) varies to the extent of 180°, so that, though central with a longitude of $20^{\circ}\cdot7$ on Dec. 24, 1881, at 9h. 43m., this object was at longitude $202^{\circ}\cdot7$ on Dec. 2, 1881, at 6h. 44m., when I saw it presented on the planet's C.M. To show the interesting variation in longitude of this spot, comparatively to the red, I may adduce a few transits observed here during the period Dec. 10, 1881—Jan. 9, 1882, with their equivalent longitudes as derived by Mr. Marth:—

		Red Spot.			Bright spot.		
		On C. M.	Equiv. long.		On C. M.	Equiv. long.	
1881		h. m.	°		h. m.	°	
Dec.	10	8 12	19·6	...	11 26	136·9	
	13	5 40	19·1	...	8 12	111·0	
	18	4 47	19·3	...	6 12	70·7	
	22	8 2	18·9	...	8 33	37·6	
	23	3 55	20·0	...	4 11	29·6	
	24	9 43	20·7	...	9 43	20·7	☌
1882.							
Jan.	3	7 57	20·5	...	5 44	300·1	
	5	9 35	20·5	...	7 5	289·8	
	6	5 30	22·7	...	12 34	279·0	
	7	11 19	24·0	...	8 13	271·6	
	9	2 58	21·9	...	9 27	257·0	

During the 30 days selected for this comparison, the longitude of the red spot increased about 3°, while the bright spot lost $239^{\circ}\cdot9$, or two-thirds of the sphere.

Evidently, therefore, it is useless to expect exact agreements between two sketches made on separate dates. The brilliant spot near the equator of Jupiter gains a complete revolution on the red spot in $44\frac{1}{2}$ days, so that drawings made conformable with this period will at least show two of the principal objects in the same relative positions, but many of the other markings become displaced in the interim, and it must be confessed that no two sketches of the planet can be held to represent the same identical features in similar positions. In this respect Jupiter appears to offer a great contrast to Mars, whose permanent markings seem to be under the control of a common period.

There is obviously a vast difference between the surface phenomena of the two planets. The curious series of currents which so rapidly displace some of the prominent markings on Jupiter form a most interesting subject for further investigation, and it is probable that phenomena of similar character (though less decided and certainly observable with greater difficulty) are visible on Saturn for the rotation periods determined by W. Herschel in 1793 and by A. Hall in 1877, show a difference of 1m. 32s., which is too large to be attributed to the ordinary errors of observation. It is rather significant that the bright spot seen by Prof. Hall on this planet in December, 1877, moved so much swifter than Herschel's quintuple belt of November—December, 1793.

Bristol: Aug. 5, 1882. W. F. DENNING.

PTOLEMÆUS.

Sir,—In "Lunar Work for August, 1882," (*Astronomical Register*, August, p. 192) the Rev. Dr. Richards, referring to an observation of this walled plain by Mr. Ingall, says that the crater there called *B* is not shown in either Neison's or Beer and Mädler's map, and requires confirmation. I trust he will pardon me if I fail to comprehend upon what grounds that statement was made. Mr. Ingall's crater *B* is very nearly in the same place as the crater No 2 in my sketch of June 23, 1882 (see *English Mechanic*, Vol. XXXV., p. 399), and is identical with the Ptolemæus *d* of Beer and Mädler and Neison. This is quite clear from micrometrical measures, and also from photographic evidence. One of the peculiarities of this crater, as seen by Mr. Ingall, was its invisibility with powers of less than 225. It is now one of the most conspicuous objects upon the floor, and should be seen with ease under any illumination with an instrument of 2-in. aperture.

With regard to the two large depressions seen on the floor by Schröter, Schmidt in his large map shows the more northern one most distinctly, and indicates its apparent nature, as seen lately, very accurately, but it is perhaps shown a little too small. Schmidt also gives several nearly circular spaces enclosed by very low faint ridges, and occupying the positions of some of Mr. Ingall's depressions.

The floor of Ptolemæus is deserving of the most careful scrutiny with powerful telescopes. Not many of the low delicate ridges represented in the maps of Beer and Mädler and Neison can be satisfactorily identified with those delineated by Schmidt, and

several which I have seen are quite different from any contained in these maps. As an instance of apparent discrepancy, may be mentioned the crater *c*. Beer and Mädler represent it as a good-sized ring, with a minute interior crater-pit; Neison shows it as a minute craterlet; but Schmidt strangely omits it altogether. On Feb. 6th, 1881, I saw it as a small crater cone, and frequently since as a small rather faint light spot. Another somewhat curious feature is the large depression or shallow crater shown by Beer and Mädler, a little south of the large crater *A*. Neison shows nothing of this, but in Schmidt's map it appears very conspicuously similar to Beer and Mädler's representation. To me it has never appeared as a depression at all, even under very oblique illumination, but always as a large bright patch, in this respect resembling Schröter's northern pit. On the edges of this patch are three bright spots, one at least of which is a crater cone.

West Brighton:
August 19, 1882.

Yours faithfully,
A. STANLEY WILLIAMS.

THE AUGUST METEORS.

Sir,—On the evening of August 6, between 10h. 30m. and 11h. 30m., I saw 20 shooting stars, of which seven belonged to the shower of Perseids.

The night of August 10 was generally overcast, but occasionally a few meteors were seen through breaks in the clouds. At 13h. the eastern sky was pretty clear, and 12 meteors were recorded up to 13h. 20m., when it again clouded over. Of these eight were Perseids with a radiant centre at α 43°, δ 57°+.

The ensuing night (Aug. 11) was much more favourable. Between 10h. 45m. and 12h. 15m. I counted 61 meteors, of which 45 were Perseids. The numbers were increasing when, soon after 12h. 15m., a fog gradually obliterated the stars. From the carefully noted tracks of ten foreshortened Perseids, I derived a very exact radiant point at α 46°, δ 57° +. The meteors belonging to this shower were somewhat bright (two = ♃ and five = first magnitude stars) and streaks were, as usual, a characteristic feature.

From these slender materials it would appear that the display has returned this year with its customary brightness. The horary number of 40 observed on the night of Aug. 11 is quite up to the average, but it is unfortunate that the sky was so much overcast on Aug 10 as to prevent continuous observation.

Bristol: Aug. 17, 1882. W. F. DENNING.

EPHEMERIS FOR THE SEARCH FOR THE COMET OF 1812.

By MM. Schulhof and Bossez.

Sun's Longitude.		True anomaly of the Comet.					
165°		90°	—75°	—60°	—45°	—30°	—15°
Sept. 9	α	11h. 42m.	9h. 30m.	8h. 51m.	8h. 37m.	8h. 33m.	8h. 35m.
	δ	+73°·6	+62°·3	+48°·8	+36°·6	+25°·7	+16°·0
		0°	+15°	+30°	+45°	+60°	+75°
	α	8h. 40m.	8h. 48m.	8h. 59m.	9h. 15m.	9h. 36m.	10h. 8m.
	δ	+7°·2	—1°·1	—9°·1	—16°·9	—24°·8	—32°·6
170°		90°	—75°	—60°	—45°	—30°	—15°
Sept. 12	α	12h. 22m.	9h. 58m.	9h. 9m.	8h. 52m.	8h. 47m.	8h. 47m.
	δ	+72°·6	+62°·7	+49°·3	+36·6	+25°·2	+15°·1
		0°	+15°	+30°	+45°	+60°	+75°
	α	8h. 52m.	8h. 59m.	9h. 10m.	9h. 26m.	9h. 48m.	10h. 20m.
	δ	+5°·9	—2·°6	—10°·7	—18°·6	—26°·4	—33°·9
175°		90°	—75°	—60°	—45°	—30°	—15°
Sept. 18	α	12h. 59m.	10h. 27m.	9h. 29m.	9h. 8m.	9h. 1m.	8h. 59m.
	δ	+71°·4	+63°·1	+49°·8	+36°·7	+24°·8	+14°·1
		0°	+15°	+30°	+45°	+60°	+75°
	α	9h. 3m.	9h. 11m.	9h. 22m.	9h. 38m.	10h. 0m.	10h. 32m.
	δ	+4°·5	—4°·3	—12°·5	—20°·4	—28°·0	—35°·2
180°		90°	—75°	—60°	—45°	—30°	—15°
Sept. 23	α	13h. 34m.	10h. 57m.	9h. 50m.	9h. 24m.	9h. 14m.	9h. 12m.
	δ	+69°·9	+63°·4	+50°·4	+36°·8	+24°·3	+13°·0
		0°	+15°	+30°	+45°	+60°	+75°
	α	9h. 15m.	9h. 22m.	9h. 33m.	9h. 49m.	10h. 12m.	10h. 44m.
	δ	+3°·0	—6°·1	—14°·4	—22°·3	—29°·7	—36°·6

LUNAR WORK FOR SEPTEMBER, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Capuanus. This formation in the south-east quadrant of the moon has been carefully studied by Messrs. Gray and Allison, who have done so much useful work on the streaks seen on the floors of lunar plains. They observed the following objects:—

On the floor—Three vertical and two horizontal streaks.
On the wall—The craters *A* and *B*, and a third not named; also a small double crater in the north.

In addition to the above they noticed two more vertical streaks, a minute crater-pit on the north-east portion of the floor, and a marking on the south-west part; also a white spot north of *A* (perhaps identical with the marking ?), and on the wall:—a crater near *A*; two spurs from *B*, one towards the north-east and the other towards the south; *on* the north wall are three hollows, and *from* it two northward arms, also a zigzag ridge running south from *A*.

An observation by Mr. Allison, dated Sept. 17, 1880, seems to suggest that the streaks may to some extent have their origin in variations in the evenness of the floor. The effect caused by the light streaks crossing each other at right angles is singular, and in this respect the difference is marked between Capuanus and Plato or Archimedes.

The following selected notes of observations by Messrs. Gray and Allison will be useful for the study of *Capuanus*.

1880, April 22, 9h. 30m. (T. P. Gray). The eastern streak was breader than the other two, and more curved. The central streak was not continuously visible; its south end started from *Capuanus A*. The western streak was seen most easily; it was slightly curved, became narrower towards the north, and ended at a marking on the north wall.

1880, July 19, 11h. 10m. (T. P. Gray). The western streak was thin, clear, and curved. The other streaks only glimpsed.

1880, July 20, 12h. om. The western streak easily seen. The other two so difficult that their position is uncertain. The character of the streaks is much the same as that of the markings on *Archimedes*.

1880, July 24, 11h. 45m (T. P. Gray. N.B.—Two horizontal streaks are shown in the drawing). It is difficult to say whether the two streaks drawn from W. to E. were only apparently so, being caused by bright points in the vertical streaks, or were real streaks. The S. one was especially uncertain. The W. streak terminated at a white spot on or against the northern wall.

1880, Sept. 14, 11h. om. (Rev. F. B. Allison). One band on *Capuanus*, S. to N. on W. side.

1880, Sept. 17, 9h. om. (Rev. F. B. Allison). North the crater *A* appears a dot, which may be a small crater surrounded by aureole, which is embraced by an arm from the west streak. This arm reaches a broken boundary running N. to S. of a bright portion of the floor which fills the east bay.

1880, Sept. 23, 11h. om. (Rev. F. B. Allison). *Capuanus* N. to S. streaks only.

1880, Oct. 14, 12h. (T. P. Gray). Transverse bands very difficult. Western band straight and clear.

1880, Oct. 19, 10h. (Rev. F. B. Allison). Streak N. to S. decidedly incomplete.

1880, Oct. 20, 9h. 30m. (T. P. Gray). Three streaks N. to S. seen. One streak E. to W.

A catalogue of the objects already named in this district is here given, but a great many objects, both peaks and craters, exist in the neighbourhood, of which drawings would be very acceptable for the extension of the nomenclature and catalogue.

St. Mary's, Bayswater.

Catalogue of Capuanus.

Origin of measures, the ring *Capuanus A*.
Unit of distance, $\frac{1}{124}$ of the moon's diameter.

Name.	*Object.*	P.	D.
Capuanus.	A nearly circular ring plain. Floor 4° bright.		
A	A small ring plain on west wall of *Capuanus*.		
B	Crater on E. wall	75	1·5
c	Crater on west wall, N. of *A*	5	0·5
d	Small ring plain S. of *Capuanus*	180	1·0
e	Small ring plain S. of *d*	180	1·5
f	Imperfect ring plain E. of *Capuanus*	95	2·5
g	Small ring plain E. of *f*	90	3·5
h	Small ring plain S.E. of *g*	95	4·8
k	Small crater on N. wall	40	1·6
l	Small crater adjoining *k* on the north	40	1·7
α	Peak on E. wall	90	1·2
β			
Γ	Peak (1758 feet) on ridge from N. wall of *Capuanus*	65	2·7
δ	A mountain peak N.W. of *Capuanus*	350	2·4
φ	The great Capuanus rill (S. 288) (east end)	65	3·2

THE PLANETS FOR SEPTEMBER.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	11 39 48	N. 2 50½	5″·1	0 57·5
	9th	12 24 24	S. 3 4	5″·4	1 10·5
	17th	13 4 34	S. 8 27	5″·8	1 19·1
	25th	13 40 2	S. 13 1½	6″·5	1 23·0
Venus ...	1st	13 26 21	S. 10 24	19″·1	2 43·7
	9th	13 28 20	S. 14 7	20″·6	2 44·2
	17th	14 30 18	S. 17 32½	22″·2	2 44·6
	25th	15 2 5	S. 20 35	24″·2	2 44·8
Jupiter ...	1st	5 51 8	N. 22 57½	34″·7	19 5·8
	9th	5 55 33	N. 22 58½	35″·5	18 38·8
	17th	5 59 17	N. 22 59	36″·3	18 11·0
	25th	6 2 16	N. 22 59	37″·3	17 42·6
Saturn ...	1st	3 37 33	N. 17 4½	16″·8	16 52·6
	9th	3 37 41	N. 17 3½	17″·1	16 21·3
	17th	3 37 21	N. 17 1	17″·3	15 49·5
	25th	3 36 33	N. 16 56½	17″·6	15 17·2
Neptune ...	22nd	3 6 31	N. 15 37½	...	14 59·1

Mercury sets about half an hour after the sun throughout the month.

Venus sets about an hour and a quarter after the sun, at the beginning of the month, the interval decreasing.

Jupiter rises an hour and a half before midnight at the beginning of the month, and then earlier each night.

Saturn rises about two hours and a half after sunset, at the beginning of the month, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR SEPT, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Fri	1		Saturn's Ring: Major axis=42"·27 Minor axis=17"·03	1st Sh. I. 1st Tr. I. 1st Sh. E.	13 46 15 2 16 0	α Pegasi — 12 14·7
Sat	2	22	Conjunction of Moon and Saturn 2° 4′ S. Sidereal Time at Mean Noon 10h. 46m. 7·92s.	1st Ec. D. 2nd Ec. D. 1st Oc. R.	11 0 10 13 22 27 14 30	12 10·8
Sun	3		Sun's Meridian Passage 0m. 46·31s. before Mean Noon	1st Tr. E.	11 47	12 6·9
Mon	4	1 26	☾ Moon's Last Quarter	2nd Tr. E. 3rd Ec. D. 3rd Ec. R.	13 10 13 26 24 15 37 38	12 2·9
Tues	5	12 0 12 46 8	Occultation of 68 Orionis (6) Reappearance of ditto Conjunction of Moon and Jupiter 2° 26′ N.			11 59·0
Wed	6					11 55·1
Thur	7					11 51·1
Fri	8			3rd Tr. E. 1st Sh. I. 1st Tr. I.	11 15 15 40 16 58	11 47·2
Sat	9			1st Ec. D. 2nd Ec. D. 1st Oc. R.	12 53 33 15 59 11 16 25	11 43·3
Sun	10			1st Tr. I. 1st Sh. E. 1st Tr. E.	11 27 12 23 13 42	11 39·3
Mon	11	8	Conjunction of Uranus and Sun	2nd Sh. E. 2nd Tr. I. 2nd Tr. E.	13 4 13 5 15 47	11 35·4
Tues	12	0 58	● New Moon			11 31·4
Wed	13			2nd Oc. R.	10 41	11 27·5
Thur	14	4 13	Conjunction of Moon and Mercury 2° 10′ N. Conjunction of Moon and Mars 3° 20′ N.			11 23·6
Fri	15		Illuminated portion of disc of Venus=0·545 Illuminated portion of disc of Mars=0·981	3rd Tr. I. 3rd Tr. E. 1st Sh. I.	12 48 15 20 17 34	11 19·7
Sat	16	5	Conjunction of Moon and Venus 1° 28′ S.	1st Ec. D.	14 46 55	11 15·7
Sun	17		Sidereal Time at Mean Noon 11h. 45m. 16·21s.	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	12 2 13 22 14 17 15 37	11 11·8

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. α Pegasi
Mon	18		Sun's Meridian Passage 5m. 54·97s.	1st Oc. R. 1st Sh. I. 2nd Sh: E. 2nd Tr. I.	12 48 12 56 15 39 15 40	— 11 7·9
Tues	19			1st Tr. E.	10 6	11 3·9
Wed	20	1 27 9 19 10 10 4 19	☽ Moon's First Quarter Occultation of μ Sagittarii (4) Occultation of 15 Sagittarii (5) Conjunction of Mercury and Spica 0° 12′ S. Conjunction of Mars and Mercury 2° 21′ S.	1st Oc. R.	13 14	11 0·0
Thur	21	7 50 9 5	Occultation of B.A.C. 6530 (6½) Reappearance of ditto Saturn's Ring : Major axis=43″·77 Minor axis=17″·57			10 56·1
Fri	22	23	Jupiter at quadrature with the Sun	3rd Sh. I. 3rd Sh. E. 3rd Tr. I.	11 27 13 52 16 49	10 52·1
Sat	23	6 6 6 33	Occultation of 8 Aquarii (6) Reappearance of ditto	1st Ec. D.	16 40 17	10 48·2
Sun	24			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	13 56 15 16 16 11 17 31	10 44·3
Mon	25			1st Ec. D. 1st Oc. R. 2nd Sh I.	11 8 36 14 41 15 30	10 40·3
Tues	26	17 9 6 56	○ Full Moon Near approach of 22 Piscium (6)	1st Tr. I. 1st Sh. E. 1st Tr. E.	9 45 10 39 12 0	10 36·4
Wed	27	5 47 6 33	Occultation of δ Piscium (4½) Reappearance of ditto	2nd Ec. D. 2nd Oc. R.	10 30 3 15 54	10 32·5
Thur	28					10 28·5
Fri	29			2nd Tr. E. 3rd Sh. I. 3rd Sh. E.	10 13 15 26 17 52	10 24·6
Sat	30	16 42 17 48 6	Occultation of ω¹ Tauri (6) Reappearance of ditto Conjunction of Moon and Saturn 1° 59′ S.			10 20·7
OCT. Sun	1	16 42 17 46	Occultation of *l* Tauri (5½) Reappearance of ditto	1st Sh. I. 1st Tr. I.	15 50 17 9	10 16·7

THE MINOR PLANET CERES.

The minor planet Ceres, the first in the series, comes to opposition on Sept. 5.

	Rt. Ascen.			Decl.			
	h.	m.	s.		°	′	″
Sept. 2	23	24	49·46	S.	21	0	33·9
5	23	22	21·06	S.	21	6	23·4

Books received.—Vade Mecum de l'Astronomie. Par J. C. Houzeau. Bruxelles: F. Havez. 1882.—Stonyhurst College: Meteorological and Magnetic Results, 1881.

TO CORRESPONDENTS.

List of Subscribers unavoidably postponed.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson. 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

NOTICE.

It has been suggested to us that a General Index of our first Twenty Volumes would be both useful and agreeable to our Subscribers. Such an index could be supplied to Subscribers for 3s. 6d. per copy, in advance, provided a sufficient number of copies were ordered. If this suggestion meets with the necessary support of our Subscribers, we shall be glad to put the matter in hand. An immediate application is requested.

The Astronomical Register.

No. 238. OCTOBER. 1882.

OBSERVATORIES OF EUROPE.

(Continued from page 209.)

BERLIN. The observatory is situated at the extremity of Charlottenstrasse, in the interior and south part of the city, on a space of ground of small extent, surrounded by houses on all sides. It consists of a single mass of building, in form of a cross, with its axis west and east. On the east are the apartments of the director, the studies of the astronomers and pupils, and a part for the clocks. All the remainder is occupied by the instruments. Of these two have been recently introduced by M. Förster, an equatorial of 6-in. by Merz, with wooden tube and clockwork, with which M. Auwers observes the occultations of stars by the moon. It is placed on the south, in a dome with a double cover, the opening of which extends all the length of a meridian, only the parts near the zenith being hidden from the observer; and an altazimuth which came from the workshops of M. Bamberg, of Berlin, constructed after the ideas of M. Förster, which is placed in the north wing. The telescope is 4½-in. aperture, and 4½-ft. focal length.

In the central part of the edifice is the equatorial of 9-in. and 14-ft. focal distance, with which, on the invitation of Le Verrier, Galle discovered Neptune in the very place assigned to it by the illustrious astronomer. The spherical dome is of sheet-iron with canvas inside. It revolves on moveable rollers on an iron railway, and the motion is rendered very soft by the descent of weights, which enable the winch handle to be moved by a very

slight effort. These weights are raised again by a gas engine. The opening is only on one side of the zenith. The equatorial is by Utzschneider and Fraunhofer. The tube is of wood, and it is furnished with clockwork movement. A system of two counterpoises arranged along the tube hinders its flexure. A new and improved micrometer has quite recently been constructed by Bamberg. M. Knorre observes the small planets with this instrument. He has found a certain number which had been lost, and discovered two new ones. The micrometer screw serves for declinations; the R.A. is found by the passage over a single wire, and is registered by a chronograph. A single observation suffices, and M. Knorre has been able to observe as many as 120 stars in 15 minutes. He has formed a catalogue of 15,000 stars, most of which have been observed twice, which may be of use to him in ulterior researches, and of which he has often found the advantage.

The meridian-circle of Pistor and Martins is in the west part of the observatory. The meridian room has its walls and roof with a double metallic cover, and the roof has besides a wooden covering. The stone pillars of the instrument are enveloped in felt, and have with a space between another covering of sheet-iron, which completely isolates them. The telescope is 7-in. aperture and 5-ft. focal length. The tube is of brass. It has two circles 3·3-ft in diameter, each read by a system of four microscopes placed on the pillars. The micrometer is furnished with screws for the two co-ordinates, and the objective and the eyepiece can be interchanged. Two systems of counterpoises supported on the pillars take off from the weight of the telescope, which is reversible, and there is a bath of quicksilver for observations of the nadir, but such observations can rarely be made on account of the continual movement of vehicles in the vicinity of the observatory. There are two collimators, but no distant meridian marks. The collimators are placed on pillars of stone. A gas burner illumines the field of the telescope and the divisions of the circle under the microscopes, and a number of other burners throw light on the level, the field of the collimators and their levels, the drums of the microscopes and the MS. book of the observer; but all these sources of light are carefully excluded from the hall, being enclosed between the two metal coverings of the wall. By these precautions the temperature of the meridian room differs very little in general from that of the external air. A cloth placed between the divided circles and the observer prevents the heating of the circles when the microscopes are read. Observations are made with a chronograph of Hipp; the clock is by Tiede, of Berlin, with mercurial compensation. It is

compared with a standard clock by the same maker. With this circle M. Becker observes one of Argelander's zones between $+20°$ and $+25°$ of declin. The stars are observed in both positions of the instrument. This work is already far advanced. Adjacent to the meridian room is another in which is placed a small meridian-circle of 4-in., by Pistor and Martins, with which M. Auwers has observed a zone of Argelander, and which is at present used for the instruction of pupils. Amongst the new instruments of the observatory may be noted also an instrument for examining levels, by Reichel of Berlin, of the same form as the one which has been described in the first volume of the *Annals* of Pulkova.

St. Petersburg, PULKOVA. The observatory at Pulkova has been described by its founder, W. Struve, in a well-known volume which commences the series of the publications of that establishment.* It is nearly the same at the present day as then described. The dwelling-houses have been enlarged by reason of the continual increase of persons who under various titles live at the observatory. At first there were about a hundred inhabitants, there are now about 150. Although many of the structures which contain the instruments are of wood, they have been untouched and are in good order. In the meridian instruments few modifications have been made. The meridian telescope of Ertel is just as it was. The pivots of the vertical circle which had been worn have been turned afresh by M. Herbst, the able mechanician of the observatory; and a discovery relative to the errors of division led M. O. Struve to trace a new division by the side of the former one, and this new graduation has been thenceforth used. Some improvements have also been made in the meridian-circle of Repsold. The astronomers at present charged with the meridian service are MM. Wagner, sub-director of the observatory, for the meridian telescope; Nyrén, for the vertical circle, Romberg for the meridian circle. Every 20 years the positions of fundamental stars are determined at Pulkova; this was done for 1845 and 1865, and this year (1880) will commence the observations whose mean positions will be given for 1885. The meridian-circle has been employed for the observation of stars to the sixth magnitude between the pole and $-15°$ decl., of double stars, stars of comparison, &c. M. Romberg has observed with it without intermission since 1874. Without quitting the hall, the meridian marks are illuminated by a light behind an objective, which is brought to bear alternately on the two pillars. Not many observations are

* An account of it is also given in Piazzi Smyth's entertaining work, *Three Cities in Russia*, published many years ago.

made of the nadir. M. O. Struve thinks that, not being under the same conditions as the observations of the stars, only a relative confidence should be accorded to them. The only modification of the prime vertical instrument has been the recent fixing of two marks east and west, in order to meet certain criticisms which attributed a displacement in azimuth to the instrument. Each of these marks is upon a stone pillar surrounded by a covering of wood, the space between being filled up with materials of small conductivity. M. Nyrén also observes with this instrument. He is taking up again the determination of the constant of aberration by 25 stars in place of seven as at the first. Certain inexplicable anomalies lately interrupted this work. After many fruitless researches the cause was found in the giving way of the flooring of the hall, which was impinging against the pillar. With the correction of this the irregularities disappeared, and the observations could be renewed.

Since 1868 a standard clock by Tiede has been placed in the subterranean quarters of the observatory, beneath the central gallery and the vault supporting the 14-in. equatorial. This clock, kept at a uniform temperature and atmospheric pressure, is enclosed in a cylindrical case of glass, closed at the bottom by a plate of glass, and at the top by a plate of metal, and these are connected by two metal rods which keep them firmly pressed against the cylinder; the insulation is completed by a coating of tallow. On the upper part is a cock with an india-rubber tube, communicating with an air pump filled with dry air, which enables the pressure to be modified, and the clock's rate regulated. The pressure usually maintained is two-thirds of the atmosphere. The hygrometric condition is generally kept very feeble in order to avoid the formation of rust. The other principal clocks of the observatory are by Hohwu, of Amsterdam.

The great equatorial of 14-in. is being repaired by M. M. Repsold, who is to alter all the mechanical part, and replace the wooden tube by one of metal. The new stand, a column of cast-iron, is already fixed. The 6-in. equatorial of the west tower is employed by M. Dubiago in the measurement of double stars. The old heliometer of Fraunhofer now serves as an equatorial for the instruction of the young astronomical pupils. A new heliometer of 4-in. of improved construction by Repsold has been for some years placed in a pavilion to the south of the observatory. M. Backlund, assistant astronomer of the observatory, will make with this instrument measurements of the distances of the satellites of Jupiter from the planet. A large pavilion contains in its central part various portable instruments, and is terminated by two domes at its extremities. In the one to the east a 6-in.

equatorial with a Gauss objective, on which is mounted a photometer of Zöllner, is employed by M. Lindemann, associate astronomer and scientific secretary of the observatory, for the measurement of the light of stars in the catalogues of Argelander. He has made about a thousand observations of 600 stars. The western dome contains an instrument constructed by M. Herbst, under the direction of M. O. Struve, for the measurement of distances, for the use of the artillery. In a pavilion near the preceding is a meridian telescope by Ertel, 4-in. aperture. In the north-east a pavilion contains various portable instruments, intended, with those of the south pavilion, for the instruction of the officers of the staff under the direction of Colonel Zinger, astronomer of the observatory. Preparatory studies for geodesical work occupy an important place at Pulkova. The chief director is M. Döllen, a well-known astronomer of the observatory. A collection of rods for the measurement of base lines, is part of the material. Two bases, one of 150 metres [nearly 500 feet] in the grounds of the observatory, the other of three km. [nearly two miles] in the plain to the south, are measured by way of practice. In a short time the roof that surmounts the dome of the 14-in. equatorial will be replaced by a terrace affording a view of all parts of the horizon, for determination of azimuths. M. Döllen examines the rates of a large number of chronometers, for the most part made by M. Viren of St. Petersburgh, intended for geographical expeditions.

Spectroscopy is represented at the observatory of Pulkova by a pupil of Angström, M. Hasselberg, already the author of an important publication. He is especially engaged in the study of the effect of pressure on the spectra of gases, and the application of it as regards nebulæ and comets. If to the names already mentioned we add those of some young astronomers, such as MM. L. Struve and Rheinmal, whose entrance on an astronomical career is full of bright promise for the future, we shall have the complete list of the coadjutors of the learned director of the observatory of Pulkova. Independently of personal publications and numerous memoirs published by the Academy of Sciences, the volumes of *Annals* that have appeared of late years testify to the activity of this great establishment. Vol. IX. contains the double stars observed by O. Struve, including the stars of W. Struve, in addition to those discovered at Pulkova, confined to stars whose distances are less than 16″, and the larger at least of the seventh mag.; two circumstances that increase the chances of physical connection. This volume contains about 1,100 stars. About 100 others discovered elsewhere, and subsequently observed at Pulkova, will appear in Vol. X., which will moreover contain the

absolute mean positions of all the double stars of this category. Vol. XI. will be devoted to the observations made by M. Wagner with the meridian telescope. Vol. XII. will give the mean positions of these stars for 1865, with their discussion by M. Wagner. Vols. XIII. and XIV. will embrace the same work for the declinations, by M. Nyrén, besides the observations with the prime vertical instrument.

Amidst the manifold occupations of the director, the cares of a continual supervision necessitated by the observations, their reduction and publication, with the charge of a great number of persons, over whom he exercises an authority, which however rests more on the respect attached to his name and character—always full of kindness—than on his official position, M. O. Struve, who never ceases either observing or pursuing theoretical labours, neglects nothing in order to maintain the establishment which he directs in the rank which it occupies amongst observatories. Thus, he has resolved to endow the observatory with an equatorial surpassing in size and power all existing instruments; and having obtained from the Government the funds necessary for the construction of a telescope 30 French inches (32·7-in.) in diameter, notwithstanding his intimate acquaintance with astronomical matters, he undertook a long and fatiguing journey to the different observatories of Europe and of the United States, in order to gain every information useful for the construction of an instrument of extraordinary dimensions under the best possible conditions. The work is already in hand. The crown and flint glasses cast by M. Feil, of Paris, are being worked by Alvan Clark, the well-known American maker; the mechanical part will be entrusted to M. M. Repsold. The flint glass weighs 79 kg. (174 lbs.), the crown glass 51 kg. (112 lbs.) The focal distance will be about 43 feet. The two glasses will be six inches apart—an arrangement which will allow of the surfaces being cleaned, will preclude oxidation, admit of the airing of the objective before observing, and give facilities for achromatism. The plans for the new dome are determined, and will shortly be put in execution. A tower will be built on the S.W., of an octagonal form, 59 feet in diameter, which will be surrounded by halls to protect the instrument from extreme temperatures. The dome, of cylindrical form, will be made of a thick frame of iron, overspread with a double covering of felt. A gallery will give access to it all round. The opening will be the whole length of a meridian. This, and the apparatus for its movement, will be entrusted to Mr. Grubb, of Dublin. A long corridor will form the communication between the pavilion of the great equatorial and the observatory.

St. Petersburgh, Pawlowsk. An observatory for meteorology and magnetism, under the direction of M. Wild, is established at Pawlowsk, in the environs of St. Petersburgh, on a wooded piece of ground given by the Grand Duke Constantine. It is of recent establishment, consisting of three isolated pavilions, one for meteorology and two for magnetism; the one which contains the self-registering instruments is entirely covered by a bed of earth five feet thick. By various arrangements the temperature is maintained constantly at $+21^\circ$ C. in order to avoid the determination of the constants of temperature. The observatory possesses a fine library, to which M. Golovnin, the former minister of public instruction, has lately presented 5,000 volumes. There is also in St. Petersburg, near the harbour, a meteorological observatory, also under the direction of M. Wild; but it is in fact less of an observatory than a bureau charged with the collection and publication of the observations made in 120 stations throughout the whole empire. This work is more particularly entrusted to M. Rykatchew. The bureau receives an annual endowment of 45,000 roubles (about £7,000).

(*To be continued.*)

GREENWICH ASTRONOMICAL RESULTS.*

These are, as usual, extracted from the astronomical observations made at the Royal Observatory. 1. There is a catalogue of mean R.A. and N.P.D. for 1880, Jan. 1, of 1294 stars, observed in 1880, with the annual variations. For such of them as are not included in the Greenwich seven-year catalogue for 1864, the nine-year catalogue for 1872, or in later annual catalogues, a table of new constants is given. This very valuable catalogue contains 204 stars more than the corresponding one for 1879. 2. Horizontal and vertical diameters, and R. ascensions and N. P. distances of the sun, moon, and planets . . . compared with the corresponding results of the *Nautical Almanac*, &c., &c., &c. As to the sun, the apparent errors of the *N. A.* are very small. The apparent error in R.A. was 0·00s. four times, +0·01s. three times, —0·01s. five times, and +0·30s., the largest amount, twice. In N.P.D. the least and the greatest amounts are $0''\cdot00$, $-0''\cdot01$ (twice) and $+4''\cdot62$, $-4''\cdot17$. For the moon the least and the greatest apparent errors in R.A. are: +0·06s., +0·09s. and +1·18s., +1·14s. (twice); in N.P.D. they are $+0''\cdot20$, $-0''\cdot27$, and $-8''\cdot80$, $+8''\cdot76$. The apparent error of the *N. A.* in R.A.

* *Greenwich Astronomical Results.* 1880. pp. 95.

is always positive, as it is also in about two-thirds of the N.P.D.s. Most of the negative ones occur in the latter half of the year, from June to the middle of December, 35 in number, amongst which, however, are 11 positive. To select one of the extreme cases, June 25, when the apparent errors of the *N. A.* are 1·18s. and 5″·44, the error in the moon's place is found to be 18″·5, just equal to the vertical diameter of Saturn as measured in December, 1880. Or it is about the 100th part of the moon's mean diameter, less than half the diameter of Tycho, and equivalent to 21 miles at the centre of the moon's disc.

The apparent error of the *N. A.* for Mercury, Venus, and Mars is generally a small fraction of a second of time in R.A., and only once as much as three seconds of arc in N.P.D. (Mars) generally much less. For Ceres it is always under —10s. R.A., and from —27″ to —43″ N.P.D. For Juno in R.A. it is from —4·64s. to —5·56s. in N.P.D. —5″·64 to —9″·41. For Vesta in R.A. it is from —1·45s. to —1·63s., in N.P.D. from —4″·76 to —6″·57. For Astrea (5), Hebè (6), Iris (7), Hygeia (10), Parthenope (11), Psyche (16), Melpomene (18), Amphitrite (29), Harmonia (40), and Ariadne (42), the apparent error of *Berliner Jahrbuch* is always under 10s. R.A. and 36″ N.P.D. For Eunomia (15) it is —9s. and —61″. For Nemausa (51) —5s. and +90″. For Hermione (121) +4s. and —43″. For Eunice (185) +12s. and +1″. Massilia (20) is the most out of all, —23s. R.A. and —122″ N.P.D. Of 19 minor planets, six have been observed once, and five twice only. There are also seven observations of Irene (14), but not compared with tables. The apparent errors of *N. A.* for Jupiter are always under one second of time in R.A. + or —. In N.P.D., in 31 observations, under 1″; in seven observations greater than 1″ and under 2″; and two observations give the apparent error +2″·11 and +3″·03. The apparent error for Saturn is always + and under one second of arc, R.A. In N.P.D. always — from about 3″ to 6″; two observations gave 6″·82 and 7″·97. For Uranus the apparent error in R.A. is always — and a small fraction of a second of time. In N.P.D. it is usually — (only four times + in 33 observations), in ten observations under 1″, in 18 observations more than 1″ and under 2″, in five observations more than 2″ and under 3″; the greatest being —2″·60, the least —0″·04. For Neptune (23 observations) the apparent error in R.A. is —, with one exception, and a small fraction of a second of time. In N.P.D. the least and the greatest apparent errors are +1″·92 and —0″·05.

The solution of equations formed from observations of the sun for the position of the ecliptic make the assumed ecliptic to be north of the sun's true path at the first point of Aries by 0″·464,

so that the R.A. of all stars ought to be diminished by 0·077s.; the obliquity assumed in the *N. A.* ought to be diminished by 0″·075; and the obliquity deduced from the southern solstice is greater than that deduced from the northern solstice by 0″·060, or the mean of observed distances from the pole to the ecliptic is too great by 0″·030.

We now come to comparisons, not of single observations with the *Nautical Almanac*, but to the mean errors of the tabular geocentric places of the sun and planets. For the sun the year is divided into twelve groups of days, generally between three and four weeks each, to the mean day of which the errors in R.A., N.P.D., longitude and ecliptic N.P.D. are reduced. These are very interesting tables. We find that the greatest error of the solar tables in longitude was, Dec. 12 +2″·71, the least April 21, —0″·4. In E.N.P.D. the largest error was March 18, —0′·89, the least Feb. 14, +0″·02. In the two groups for Mercury, the error in longitude May 15 was —0″·83, E.N.P.D. —0″·88; Sept. 2, in longitude, +0″·92; E.N.P.D., +0″·80. The observations of Venus are numerous; the errors in longitude always +, with one exception, March 22, —1″·02. The greatest error in longitude Jan. 31, +3″·07; the least Feb. 20, +0″·07. In E.N.P.D. the greatest error was Nov. 24, —1″·95; the least, Sept. 3, +0″·08. The greatest and least errors in the longitude of Mars are: Jan. 20, +2″·94; March 13, +0″·06. In N.P.D. Jan. 20, —0′·62; March 13, —0″·14. In the two groups for Ceres, the errors to the nearest second are: Feb. 15, longitude —142″; E.N.P.D., +9″; March 20, longitude —124″; E.N.P.D., +11″. In the two groups for Juno, the errors are: Feb. 18, longitude —73″; E.N.P.D., +19″; March 19, longitude —71″; E.N.P.D., +18″. For Vesta the errors are: May 23, longitude —23″; E.N.P.D., —3″; June 12, longitude —23″: E.N.P.D., —2″. For Jupiter there are six groups of days, exhibiting in longitude the greatest error, Dec. 20, —1″·10, the least, Sept. 25, +0″·16. In E.N.P.D. the greatest and least errors are: Sept. 25, +0″·74; Nov. 26, —0″·02. For Saturn there are five groups. Greatest error in longitude, Sept. 17, +12″·92; least, Dec. 13, +10″·40. In E.N.P.D. the greatest and least are: Jan. 11, —2″·61; Dec. 13, —0·04. There are five groups for Uranus. Greatest and least errors in longitude, March 21, —2″·28; April 30, —1″·73. In E.N.P.D. the errors are: April 6, —0″65; March 21, —0″·32. There are four groups for Neptune. Greatest and least errors in longitude, Dec. 1, —2″·53; Jan. 21, —1″·68. In E.N.P.D. they are: Dec. 1, —1″·00; Oct. 19, —0″07. The errors of the tables of Saturn in longitude are all +. In E.N.P.D. they are all —. The errors of Uranus

and Neptune are all —, both in longitude and E.N.P.D. We pass over the tables of the tabular heliocentric places of the planets, and come to the errors of the moon's tabular places in R.A. N.P.D., longitude, and ecliptic N.P.D., from observations with the transit-circle and the altazimuth.

The observations with the transit-circle appear to be 106, including three imperfect ones. The observations with the altazimuth are 180. There is a gap during March and part of April, when the horizontal circle was being redivided. Notwithstanding, the average number of observations with this instrument are seen to be in proportion to those with the transit-circle nearly as nine to five. The following are specimens of the greatest variation between the two instruments in the moon's error in longitude: Feb. 1, over 6″; Feb. 28, over 5″; Sept. 21, over 6″; Nov. 11, over 9″. Dec. 12, over 5″. The large amount on Nov. 11 is doubtless attributable to the moon having been observed in only one position of the altazimuth, as we learn from the Remarks. And in the E.N.P.D. we find the following exceptionally large variations: April 26, over 5″; April 30, over 15″; July 24, over 5″; Sept. 12, over 5″; Sept. 23, over 9″; Oct. 12, over 6″; Nov. 8, 7″. To April 30, we find the remark, "Limb very faint; one contact of limb with horizontal wire observed for N.P.D. (transit-circle)." To Sept. 12, Remark on transit-circle observation, "Very faint; cloudy." To see what the more average variations between the two instruments might be, taking the first 22 observations of the year admitting of comparison, eight observations differed in the moon's longitude less than 1″, and less than 2″ in E.N.P.D; four observations differed less than 2″ in longitude, and 2″ E.N.P.D.; two observations differed less than 2″ in longitude, and 5″ E.N.P.D.; four observations differed less than 3″ in longitude, and 4″ E.N.P.D.; two observations differed less than 5″ in longitude, and 5″ E.N.P.D.; two observations differed less than 6″ in longitude, and 2″ E.N.P.D. The sum of the variations in longitude and E.N.P.D. is always under 8″. The greatest variation, Jan. 29, 3″·31 in longitude, 4″·64 E.N.P.D., would make the transit-circle and altazimuth differ in the moon's place by 5″·7. Considering what an evanescent quantity a second of arc is on the limb of a circle, or between the wires of a transit instrument, the general close agreement of these noble instruments strikes us as very satisfactory, and very creditable to the observers, whose initials are appended to every observation. Have these able men never heavy colds, or bad headaches, or other physical drawbacks? It is not customary to insert such particulars. Anyhow it would seem that such hindrances do not appreciably tell upon the observations.

It is a good rule at the Royal Observatory that no assistant should be occupied on two successive days with astronomical observations. The errors of the moon's tabular place in longitude are always + with both instruments. In E.N.P.D. they were 61 times + and 40 times — with the transit-circle; they were 81 times + and 99 times — with the altazimuth. But these signs vary throughout the year. In the first quarter the sign + predominates with both instruments. In the second quarter + predominates with the transit-circle and — with the altazimuth. In the third quarter — predominates decidedly in both, and in the fourth quarter + predominates with the transit-circle, and — with the altazimuth. We shall not pretend to determine which instrument may deserve the preference for lunar work, though we may have a private leaning. Observations with the altazimuth must be troublesome, and their reduction laborious, but it is a valuable instrument for particular parts of the moon's orbit, and for supplying the want of meridian observations when these are hindered by clouds. For instance, in June, 1880, only three meridian transits of the moon, and one imperfect one, could be taken. Exactly the same was the case in August, whilst with the altazimuth 16 observations were made in June, and 13 in August. Again, in May there were 20 observations with the altazimuth, to 10 and one imperfect one with the transit-circle, and 19 in November to nine and one imperfect one with the transit-circle.

We next come to the observations of γ Draconis with the reflex zenith tube and reduction of the observations. Observations extend from May 18 to Sept. 18, or 38 days. The greatest concluded mean zenith distance north, Jan. 1, 1880, is $101''\cdot04$; June 11, the least, $92''\cdot89$. Aug. 12 (to this the remark "very unsteady" is appended.) We observe that the zenith distance was obtained three times between $92''$ and $93''$; five times between $93''$ and $94''$; seven times between $94''$ and $95''$; twelve times between $95''$ and $96''$; eight times between $96''$ and $97''$, and twice between $97''$ and $98''$.

Then follow observations of the solar eclipse of 1880, Dec. 31, with the equations deduced from the differences of R.A. and from the differences of N.P.D. of the limbs and cusps. The beginning of the eclipse was noted by four observers with three equatorials and the altazimuth. The greatest difference between them was 4·5s. Two observers agreed to 0·7s. The end was observed by two persons, differing 3·7s. Twenty N.P.D.s of north and south cusps alternately, were observed in less than 15 minutes, involving the readings of two microscopes and declination micrometer. The observations were made by Mr. Christie, the microscopes were read

by Mr. Creswick. Next, ten observations were made of differences of R.A. of preceding and following cusps (20 observations), the transits being observed over ix. wires. These occupied under 19 minutes. Next, 26 observations were made of difference of N.P.D. of limbs of sun and moon, alternately, occupying less than 20m. The limbs were "boiling" very much throughout this set of observations, especially the moon's limb. Then followed 22 observations of difference of N.P.D. of preceding and following cusps, occupying less than 17m. Then 12 observations of difference of R.A. of preceding and following cusps, alternately, transits being observed over ix. wires. These occupied about 24m. About the middle of these the sun became very faint. Equations are formed from these groups of 90 observations in all (occupying 1h. 43m.) which are solved by the method of least squares, and from the final equations are deduced the following errors in the moon's place: R.A. $-15''\cdot97 = 1\cdot06$s.; N.P.D. $+0''\cdot73$, semi-diam. $-2''\cdot72$, and sun's semi-diam. $-0''\cdot32$. Observations of the sun with the transit-circle in Dec., 1880, and Jan., 1881, gave error of sun's R.A. $-1''\cdot74$, sun's N.P.D. $-0''\cdot44$. Notwithstanding the sun was so low (correction for refraction at the last observation was $6'\ 19''\cdot56$) we see that this eclipse was admirably observed, and the results of the elaborate treatment of the observations must be of considerable value.

The last part of the "Results" are the eclipses, occultations, and transits of Jupiter's satellites, compared with the *Nautical Almanac*, and occultations of stars by the moon, with the equations deduced from the occultations. The phenomena of Jupiter's satellites were observed on 23 days in the months of August to December, both inclusive. Instruments employed: the E. equatorial and the Naylor equatorial, 6-in. ap., the S.E. equatorial, 12·8-in. ap., four times, and once the altazimuth. We extract the apparent errors of the *Nautical Almanac* for the eclipses.

		m. s.
I. Sat.	Disappearance Sept. 1, mean between "first observation" and "last seen," interval about 2m. Apparent error of *N. A.* ...	−0 1·6
,,	Reappearance Nov. 2. First seen	−0 13·4
,,	Reappearance Nov. 4. First seen	+0 23·8
,,	,, ,, Mean between "first seen" and "full brightness," E. equat., interval $1\frac{1}{2}$m.	+0 44·9
,,	Reappearance Nov. 27. "First seen," E. equat.	+0 17·2
,,	,, ,, "First seen," Naylor equat.	+0 30·3

		m. s.
I. Sat.	Reappearance Dec. 20. "First seen," altazimuth	—0 59·1
	Planet faint on account of fog; the observation not satisfactory.	
II. Sat.	Disappearance Sept 7. "Last seen" ...	—0 53·4
„	Reappearance Nov. 3. "First seen" ...	+0 53·9
	Definition very bad.	
„	Reappearance Nov. 21. Mean between "first seen" and "full brightness"	+1 30·4
	Observation good.	
„	Reappearance Nov. 28. Mean between "first seen" and "full brightness"	+1 30·5
„	Reappearance Dec. 30. "First seen" ...	+ 4·8
III. Sat.	Disappearance Sept. 3. "Last seen" ...	+0 1·3
„	Reappearance Sept. 3. Mean between "first seen" and "full brightness" ...	+3 6·6
	Planet and satellites ill-defined.	
„	Disappearance Nov. 21. Mean between "first observation" and "last seen" ...	—0 40·9
	Observation good.	
„	Reappearance Nov. 21. Mean between "first seen" and "full brightness." Naylor equat.	+5 1·0
„	Reappearance Nov. 21. Mean between "first seen" and "full brightness." E. equat.	+5 12·2

The IV. Sat. was not observed. On Oct. 2 the I. Sat. could be traced for a quarter of an hour on the disc of Jupiter after ingress, and was distinctly brighter than the surface of the planet near the limb. On Nov. 3, about 11m. after last contact it was invisible on the planet. At the occultation of Sat. III., Nov. 28, at disappearance, the satellite was very distinctly seen through the edge of the disc.

Occultations of 12 stars were observed, nine being disappearances and three disappearances and reappearances. At the disappearance of ϵ Arietis (5m.) at the moon's dark limb, Jan. 20, the star seemed to disappear gradually. It will be remembered that this is a close double which Σ discovered, and which he described as perhaps the closest of all then known (Dist. Wilson and Seabroke 1877, 1″·36). The reappearance of η Geminorum (4m.) at the dark limb, Nov. 19, was not sudden; the star was first seen as a very small spot, and in about 0·2s. or 0·3s. it flashed out to its full brightness. The occultations were

observed with the E. equatorial and the altazimuth. Spectroscopic and photographic results now appear in a separate volume.

Having thus presented a pretty full synopsis of the contents of this volume, but not too full, we think, for the interest and value of the subjects, we can wish nothing better for every department of Her Majesty's service than that they might be served with a like amount of the conscientiousness, ability, and zeal that characterise all that is done at the Royal Observatory.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

THE RED SPOT ON JUPITER.

Sir,—This object is becoming extremely faint, and I question whether it will continue visible after the present apparition of Jupiter. Its motion appears to have been slightly accelerated during the past few months, as compared with its rotation period of last winter. Between July 8, 1881, and March 30, 1882, the spot lost 39·6 min. on Mr. Marth's first meridian, according to observations at this station, as will be seen by the following table, in which I have selected one observation for each month:

Date.		Red Spot Observed on C. M.			Follows Marth's 1st Meridian.
1881.		h.	m.		min.
July 8	...	15	36	...	8·5
Aug. 8	...	16	10	...	10·8
Sept. 7	...	10	54	...	13·6
Oct. 3	...	12	15	...	16·6
Nov. 2	...	6	57	...	23·6
Dec. 8	...	6	30	...	28·2
1882.					
Jan. 9	...	2	58	...	36·3
Feb. 8	...	7	48	...	42·8
Mar. 30	...	9	16	...	48·1

During this interval of 265 days the middle of the spot followed the first meridian by an interval increasing from 8·5m. to 48·1m.,

which is nearly equivalent to 5m. per month. Now, had this retarded motion of the spot, relatively to the period of 9h. 55m. 34·47s. on which Mr. Marth's computations are founded, been continued since the observations of March 30, the interval must have increased from 48m. to 73m. by the middle of the present month. But I find the previously slow motion has not been sustained during the past summer, for on Sept. 13 and 15 I carefully observed the spot and found it to follow Mr. Marth's assumed first meridian by only 57·5m. on both nights. It is evident, therefore, that during the last 5½ months the motion of the spot has been accelerated to the extent of some 15m., as compared with its average velocity during the previous apparition. During the period from March 30 to August 7, the spot appears to have conformed almost exactly with the period of 9h. 55m. 34·47s., for on the former date it followed the first meridian by 48·1m., and on the latter by 47·1m. It will be interesting to watch the future behaviour of this remarkable object in regard to its variable motion, and now that its early disappearance is to be inferred from rapidly increasing faintness, it should be more closely observed for phenomena which may not have affected its earlier stages of existence.

Yours faithfully,

Bristol: Sept. 20, 1882. W. F. DENNING.

THE TRANSIT AND THE BLACK DROP.

Sir,—Will you again allow me a word *re* the "Black Drop," as I cannot, I fear, make the matter, from my point of view, as clear as I should like to do. It has always been thought, as it was by Newton certainly, that light in passing by or close to the edge of any object, is, by the presence of such object, turned from its otherwise straight course, and *deflected* or *inflected* by it, and that it is so was thought to be proved by the fact of the outlines or edges of all shadows being *shaded off* or *fringed*, such shadows I mean as are cast by all objects when exposed to the sun's light, or the light of a lamp or candle flame of *measurable* size. It was, and is now, I believe, thought universally by men of science, that the *edges* of all bodies possess the power of either *attracting* or *repelling* the rays of light as they approach and pass them. I cannot but think that this is an error, and that the *undefined* or *shaded off* outlines of all shadows of objects as thrown by the sun or the flame of a candle, or other light, is caused, and caused simply, by the linear *size* of the sun's light or lamp flame. This by way of illustration. The *black drop*, as seen in a transit, and

as seen by all observers, is caused, and caused solely, by the *size* or *measurable dimensions* of the *eye-pupil* through which the observer sees the approaching and touching bodies, *e.g.*, of the sun and Venus in a transit. That this is so I think is proved by the fact that if you look at two penny pieces against a clouded sky or sheet of white paper, and note the *drop* between them, as they touch, this drop disappears entirely, if but the touching discs be looked at through a fine needle-point hole pierced in a thin plate. Cannot this fact be made use of in the coming transit work?

C. BRUCE ALLEN.

[We publish Mr. Bruce Allen's letter, as it suggests a source of error in observations made with an artificial transit model. The size of the pupil of the eye of course vanishes as seen from Venus. Mr. Bruce Allen is mistaken in assuming that the fringes referred to by Newton are believed by modern men of science to be due to attraction or repulsion of the rays of light by the edge of the body casting the shadow. Such fringes are accounted for, according to the undulatory theory, as being due to interference. But his letter would not be intelligible unless given as a whole.—EDITOR.]

LUNAR WORK FOR OCTOBER, 1882.

By the REV. W. J. B. RICHARDS, D.D., F.R.A.S.

MARE SERENITATIS. Attention was called in April last (see p. 94) to the curious horned shadow sometimes cast by *Bessel*. As further observations are needed for the clearing up of the meaning of this horned appearance, observers are reminded that *Bessel* will be well placed in sunset on Oct. 2.

On the same subject Mr. Elger contributed to the *Selenographical Journal*, of June 15, the following note of an observation made on Jan. 16, 1872, at 9h. 30m.: "In addition to the long, needle-pointed horns north and south, I saw a third about midway between them, not quite so long, which evidently pertains to the east wall. I have a distinct recollection of making the sketch, solely because of the peculiarity of the shadow of the ring. Definition was very good, and I used a power of 200 on my 4-in. Cooke. The crater on the north is *Bessel A*. I have a drawing of *Bessel*, made in Feb., 1873, near sunset, but I do not appear to have observed anything abnormal in the shadow of the ring under evening illumination." It is added by the Editor that these points were well shown in the drawing that accompanied the note.

Hyginus. A catalogue of the objects observed and confirmed in this district is given below. Corrections of the positions and distances, which are here given roughly, but it is hoped with sufficient accuracy for the ready identification of the objects, would be very useful.

St. Mary's, Bayswater:
Sept. 21, 1882.

District Catalogue of Hyginus.

Origin of measures, the centre of Hyginus.

Unit of distance, $\frac{1}{124}$ of the moon's diameter.

Mountains, elevations, and bright spots are indicated by Greek letters and odd numerals.

Craters, depressions, and dark spots by Roman letters and even numerals.

Rills by Roman numerals.

Name.	*Object.*	P.	D.
Hyginus.	A crater-pit, 5°·5 bright, 3·7 m. wide, lat. +8° 2', long. +6° 22'.		
Schneckenberg.	A spiral mountain N. of *Hyginus*, enclosing a crater-like depression, height 500 to 700 feet	360	1·3
a	Crater 6°·5 bright, 3·2 m. wide, very deep	160	1·6
b	Crater 5°·5 bright, 2·4 m. wide, 2,000 ft. deep	110	0·9
c	Crater 5° bright, 2 m. wide, 1,000 ft. deep	250	1·8
D	Crater E. of δ	30	3·5
E	Large ring or crater on λ	330	2·9
e	Craterlet E. of *Hyginus*, at the end of iv. Aligns γ : *Hyginus* : *e*	80	0·7
f	Shallow depression N. of *Hyginus* (distance to centre)	330	0·3
g	Craterlet on N.E. part of the *Schneckenberg*. Aligns *Hyginus* : *w* : *g*	10	1·6
h	Valley between *Schneckenberg* and *i*	350	1·8
i	Valley W. of *h*, between κ and λ	320	2·4
j	Valley W. of *i*, between λ and μ	310	2·2
k	Crater N. of *b*	70	1·3
m	Circular dark patch S. of *Hyginus*	160	0·5
n	Oval dark patch, fainter than *m*. Aligns *Hyginus* : *m* : *n*	170	1·3
N	Depression or crater, larger than *b*, smaller than *a*. Aligns *c* : *x* : *N*	330	1·3
o	Dark patch S. of *Hyginus* rill and *c*	230	2·0
p	Craterlet	280	2·2
q	Crater cone	300	1·4
r	Craterlet S.W. of *c*	250	2·0
s	Crater, 1 m. wide, N. of *Hyginus*. Aligns *p* : *x* : *s* (?)	310	0·5
T	Rill-like valley, extending from *Schneckenberg* towards *Hyginus* (distance of N.E. end)	10	0·6
t	Brilliant craterlet S. of *N*.	330	1·1
v	Craterlet between walls of *Schneckenberg*	350	1·1
w	Craterlet between walls of *Schneckenberg*, S.E. of *v*. Aligns *Hyginus* : *w* : *g*	10	0·9
x	Crater 1 m. wide, W. of *s*	290	1·0
y	Craterlet S. of *x*	260	0·4
z	Dark patch near *c*, from 3¼° to 2¼° bright	270	2·5
β	Peak on the *Schneckenberg*	350	0·9

Name.	*Object.*	P.	D.
δ	Mountain N. of *Schneckenberg* (distance of N. end)	10	3·0
δ 1	Mountain E. and extending N. of *Schneckenberg* (distance of S. end)	30	1·0
η	Peak on N. ridge of *Schneckenberg*	360	1·9
κ	Mountain ridge bounding *i* on the S.E.	320	1·5
λ	Mountain ridge dividing the valleys *i* and *j*	320	2·2
μ	Mountain ridge bounding *i* on the N.W.	330	2·0
ξ	Long shaped hill at N. end of *Hyginus* rill (distance of N. end)	40	3·6
π	Hill close to *Hyginus* rill on the E.	50	1·6
ρ	Lofty ridge, extending from *N* to *r* (distance half-way from *N* to *r*)	290	1·5
σ	Lower ridge E. of ρ (northern end)	320	1·4
2	Craterlet E. of *Hyginus*	90	1·5
4	Craterlet E. of *Hyginus*, N. of iv.	60	0·5
6	Craterlet S. of rill *Hyginus* i.	230	1·9
8	Craterlet W. of *a*	190	1·6
10	Craterlet S.W. of 8	210	2·0
12	Craterlet S.E. of 10	200	2·1
14	Craterlet N.E. of *z*	270	2·8
16	Small crater S.W. of *Hyginus*	230	3·7
18	Crater on N. border of *Hyginus*	360	0
20	Depression (dark spot) close to the S. of *Hyginus*	200	0
22	Crater pit in i.	250	0·4
24	Crater pit in i., west of 22	250	0·6
26	Crater pit in i., west of 24	250	0·9
28	Crater pit in i., west of 26	250	1·0
30	Crater pit in i., west of 28	250	1·5
32	Crater pit in ii.	40	1·0
34	Crater pit in ii., N.E. of 32	40	1·2
i.	S.W. branch of *Hyginus* rill	250	
ii.	N.E. branch of *Hyginus* rill	40	
iii.	Short branch from E. side of ii.	40	1·5
iv.	Short rill from *Hyginus* eastward	80	
v.	Short rill from *Hyginus*, north of iv.	70	
vi.	Rill running eastward from *D*	20	3·6
vii.	Rill from near *Schneckenberg* *D* towards *p* (Neison's ψ)	250	2·5
viii.	Broad rill from *Ariadæus* rill to *i* and *j* (Neison's θ)	270	2·3
ix.	Short rill W.S.W. of *b*	120	0·5
x.	Part of rill from *Triesnecker* district	90	1·4
xi.	Part of rill from *Triesnecker* district, S. of *b*	140	1·0
xii.	Rill joining *Hyginus* rill on the W. (Neison's φ)	240	2·3
xiii.	Branch from *Ariadæus* rill to *Hyginus* rill (Neison's ξ)	250	2·2

EPHEMERIS FOR THE SEARCH FOR THE COMET OF 1812.

By MM. Schulhof and Bossert.

Sun's Longitude.		True anomaly of the Comet.					
190°		90°	—75°	—60°	—45°	—30°	—15°
Oct. 3	α	14h. 35m.	12h. 4m.	10h. 36m.	9h. 58m.	9h. 42m.	9h. 37m.
	δ	+66°·5	+63°·6	+51°·8	+37°·3	+23°·3	+10°·6
		0°	+15°	+30°	+45°	+60°	+75°
	α	9h. 39m.	9h. 45m.	9h. 56m.	10h. 12m.	10h. 36m.	11h. 8m.
	δ	—0°·5	—10°·1	—18°·7	—26°·5	—33°·5	—39°·5
195°		90°	—75°	—60°	—45°	—30°	—15°
Oct. 8	α	15h. 3m.	12h. 39m.	11h. 1m.	10h. 17m.	9h. 57m.	9h. 50m.
	δ	+64°·6	+63°·4	+52°·5	+37°·7	+22°·7	+9°·2
		0°	+15°	+30°	+45°	+60°	+75°
	α	9h. 51m.	9h. 57m.	10h. 8m.	10h. 22m.	10h. 48m.	11h. 20m.
	δ	—2°·4	—12°·5	—21°·1	—28°·8	—35°·5	—41°·1
200°		90°	—75°	—60°	—45°	—30°	—15°
Oct. 13	α	15h. 27m.	13h. 16m.	11h. 30m.	10h. 37m.	10h. 13m.	10h. 4m.
	δ	+62°·6	+63°·0	+53°·4	+38°·3	+22°·2	+7°·7
		0°	+15°	+30°	+45°	+60°	+75°
	α	10h. 3m.	10h. 8m.	10h. 19m.	10h. 36m.	11h. 0m.	11h. 33m.
	δ	—4°·6	—14°·9	—23°·7	—31°·2	—37°·5	—42°·7
205°		90°	—75°	—60°	—45°	—30°	—15°
Oct. 18	α	15h. 51m.	13h. 53m.	12h. 1m.	10h. 58m.	10h. 29m.	10h. 17m.
	δ	+60°·6	+62°·3	+54°·2	+38°·9	+21°·8	+6°·0
		0°	+15°	+30°	+45°	+60°	+75°
	α	10h. 16m.	10h. 20m.	10h. 31m.	10h. 48m.	11h. 12m.	11h. 45m.
	δ	—7°·1	—17°·8	—26°·4	—33°·8	—39°·7	—44°·4
210°		90°	—75°	—60°	—45°	—30°	—15°
Oct. 23	α	16h. 13m.	14h. 30m.	12h. 33m.	11h. 23m.	10h. 45m.	10h. 32m.
	δ	+58°·6	+61°·4	+55°0	+39°9	+21°·4	+4°·2
		0°	+15°	+30°	+45°	+60°	+75°
	α	10h. 29m.	10h. 33m.	10h. 43m.	11h. 0m.	11h. 25m.	11h. 58m.
	δ	—9°·8	—20°·8	—29°·4	—36°·3	—41°·9	—46°·1

DUN ECHT CIRCULAR, No. 54.

Mons. Cruls telegraphs from Rio de Janeiro, by the *Science Observer* Code, the discovery of a comet on September 11·718 M. T. (Rio?) in—

R.A. 9h. 48m. Decl. —2° 1′

M. Cruls says that it is visible to the naked eye, and probably the expected Comet Pons of 1812.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, September 14.

DUN ECHT CIRCULAR, No. 55.

A *Science Observer* telegram from Boston, U.S., announces the discovery of a comet by Barnard on Sept. 10 (?), described as circular, 2′ in diameter, with some central condensation, and of the tenth magnitude.

It was observed at Harvard College, Sept. 14·8162 G.M.T. in—

R.A 7h. 19m. 17·8s. Decl. +16° 3′ 51″.

Daily motion in R.A. = +1m. 44s., in Decl. = +43′.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, September 16.

DUN ECHT CIRCULAR, No. 56.

Mr. A. A. Common telegraphs:—

"Bright comet found at ten forty-five this [Sunday] morning, five minutes preceding sun, approaching fast, most likely that in Circular 54."

And in a later telegram:—

"At 10h. 59m. yesterday [Sunday] comet preceded sun's centre 6m. 50s., at 12 o'clock 5m. 44s. At 11h. 10m. comet south of sun's limb 18′ at 12h. 6m. south of sun's limb 13′. Nucleus to right (?). Tail about 4′ long." Whence:—

Greenwich M. T.	α Comet.	δ Comet.
h. m.	h. m. s.	° ′
Sept. 16, 22 59	11 32 43	...
16, 23 10	...	+1 38·7
17, 0 0	11 33 58	...
17, 0 6	...	+1 42·8

Mr. Lohse observed the comet in the meridian:—

Dun Echt M.T.	α Comet.	δ Comet.
Sept. 17, 23h. 41m. 58s.	11h. 31m. 9s,	+1° 23′ 33″

The daily motion is about—

—10m. 53s. and —57′ (in Decl.).

Spectrum of nucleus continuous with many bright lines, of which D is by far the brightest, all the bright lines displaced towards the red by about ⅛th of the interval of the D lines.

In Circular 55 the daily motion in Declination should be —43′.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, September 18.

DUN ECHT CIRCULAR, No. 57.

Elements and Ephemeris of Comet Barnard, computed by Mr. S. C. Chandler, jun., of Harvard College, from observations on September 13, 14 and 16.

Elements.

$T = 1882$, November 5·84. Greenwich M. T.

$\varpi - \Omega = 235^\circ\ 11'$ }
$\Omega = 249\ \ 39$ } Mean Equinox 1882·0
$i = 83\ \ 27$ }
$\log q = 0{\cdot}07962$

C—O; $\Delta\lambda.\cos\beta = +0'{\cdot}1$; $\Delta\beta = -0'{\cdot}1$

Ephemeris for Washington Midnight.

1882	α h. m. s.	δ ° ′	Brightness.
Sept. 21	7 32 28	+10 19	1·34
25	7 40 16	6 38	
29	7 49 0	+ 2 9	
Oct. 3	7 57 40	— 2 38	2·04

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, September 20.

THE PLANETS FOR OCTOBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	14 1 57	S. 15 40½	7″·1	1 21·3
	9th	14 19 11	S. 17 31	8″·3	1 7·0
	17th	14 11 3	S. 15 59	9″·7	0 27·4
	25th	13 35 43	S. 9 51	9″·6	23 16·8
Venus ...	1st	15 25 36	S. 22 34	26″·1	15 25·9
	9th	15 56 0	S. 24 46½	28″·8	2 43·6
	17th	16 24 30	S. 26 26	32″·5	2 40·5
	25th	16 49 38	S. 37 31½	36″·6	2 34·1
Jupiter ...	1st	6 3 59	N. 22 59½	38″·1	17 24·4
	9th	6 5 32	N. 22 59½	38″·9	16 50·8
	17th	6 6 10	N. 22 59½	39″·9	16 19·9
	25th	6 5 53	N. 23 0	40″·9	15 48·2
Saturn ...	1st	3 35 41	N. 16 52½	17″·7	14 52·8
	9th	3 34 9	N. 16 46	17″·8	14 19·8
	17th	3 32 15	N. 16 40½	18″·0	13 46·5
	25th	3 30 3	N. 16 30	18″·2	13 12·8
Neptune ...	4th	3 5 38	N. 15 34	...	14 11·0
	20th	3 4 7	N. 15 26½	...	13 6·6

Mercury sets about twenty-five minutes after the sun at the beginning of the month, the interval decreasing. On the 23rd he rises 1h. 40m. before the sun.

Venus sets about an hour and ten minutes after the sun throughout the month.

Jupiter rises about three hours and a half after sunset on the 1st, the interval decreasing.

Saturn rises rather more than an hour and a half after sunset at the beginning of the month, the interval decreasing.

ASTRONOMICAL OCCURRENCES FOR OCTOBER, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. α Pegasi
Sun	1	 16 42 17 36	Sidereal Time at Mean Noon 12h. 40m. 27·94s. Occultation of *l* Tauri (5½) Reappearance of ditto	1st Sh. I. 1st Tr. I.	15 50 17 9	10 16·8
Mon	2	11 22 12 22 15 48 17 2 20	Occultation of χ^2 Orionis (6) Reappearance of ditto Occultation of χ^3 Orionis (6) Reappearance of ditto Conjunction of Moon and Jupiter 2° 51′ N.	1st Ec. D. 1st Oc. R. 1st Sh. I.	13 2 16 34 18 5	10 12·8
Tues	3	14 17	☾ Moon's Last Quarter Sun's Meridian Passage 10m. 58·79s. before Mean Noon	1st Sh. I. 3rd Oc. D. 1st Tr. I. 1st Sh. E. 3rd Oc. R. 1st Tr. E.	10 18 10 33 10 37 12 33 13 7 13 52	10 8·9
Wed	4			1st Oc. R. 1st Ec. D.	11 2 13 6 25	10 4·9
Thur	5	13 7 13 51	Occultation of B.A.C. 2872 (6) Reappearance of ditto			10 1·0
Fri	6	17 25 18 37	Occultation of ω Leonis (6) Reappearance of ditto	2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	10 0 10 4 12 43	9 57·1
Sat	7					9 53·2
Sun	8			1st Sh. I.	17 44	9 49·2
Mon	9			1st Ec. D.	14 55 26	9 45·3
Tues	10			3rd Ec. D. 3rd Ec. R. 1st Sh. I. 1st Tr. I. 3rd Oc. D. 1st Sh. E. 1st Tr. E. 3rd Oc. R.	9 20 20 11 38 6 12 52 13 29 14 23 14 27 15 44 16 57	9 41·4
Wed	11	18 1	● New Moon Saturn's Ring: Major axis=45″·04 Minor axis=17″·93	1st Oc. R. 2nd Ec. D.	12 53 15 42 40	9 37·4
Thur	12			1st Sh. E. 1st Tr. E.	8 56 10 12	9 33·5
Fri	13	7 8	Conjunction of Moon and Mercury 2° 6′ S. Conjunction of Moon and Mars 1° 15′ N.	2nd Sh I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	9 56 12 28 12 39 15 12	9 29·6
Sat	14		Sidereal Time at Mean Noon 13h. 31m. 43·12s.			9 25·6
Sun	15	16	Conjunction of Moon and Venus 6° 11′ S. Illuminated portion of disc of Venus=0·379 Illuminated portion of disc of Mars=0·992	2nd Oc. R.	10 13	9 21·7

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Mon	16	11	Conjunction of Venus and α Scorpii 0° 9′ N.	1st Ec. D.	16 48 54	α Pegasi 9 17·7
Tues	17		Sun's Meridian Passage 14m. 35.03s. before Mean Noon	3rd Ec. D. 1st Sh. I. 1st Tr. I. 3rd Ec. R. 1st Sh. E. 1st Tr. E.	13 18 48 14 6 15 19 15 37 52 16 21 17 34	9 13·8
Wed	18			1st Ec. D. 1st Oc. R. 1st Ec. D.	11 17 17 14 43 18 18 48	9 9·8
Thur	19	11 54	☽ Moon's First Quarter	1st Tr. I. 1st Sh. E. 1st Tr. E.	9 47 10 49 12 2	9 5·9
Fri	20			1st Oc. R. 2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	9 10 12 30 14 55 15 13 17 38	9 1·9
Sat	21			2nd Tr. E.	10 43	8 58·0
Sun	22	10 25 10 53 16	Occultation of κ Aquarii (5) Reappearance of ditto Inferior conjunction of Mercury and Sun	2nd Oc. R.	12 40	8 54·2
Mon	23	5 5 5 38 11 22 12 11 15 2	Occultation of B.A.C. 8152 (6½) Reappearance of ditto Occultation of 15 Piscium Reappearance of ditto Near approach of λ Piscium (5)			8 50·2
Tues	24	11 49 12 26	Occultation of 51 Piscium (6) Reappearance of ditto	1st Sh. I. 1st Tr. I. 3rd Ec. D.	16 17 9 18 15	8 46·3
Wed	25	14 47 15 38	Occultation of π Piscium (6) Reappearance of ditto	1st Ec. D. 1st Oc. R.	13 10 51 16 32	8 42·4
Thur	26	2 33	○ Full Moon	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	10 29 11 36 12 44 13 51	8 38·4
Fri	27	14	Conjunction of Moon and Saturn 2° 6′ S.	1st Oc. R. 2nd Sh. I. 2nd Tr. I. 2nd Sh. E.	10 59 15 5 17 19 17 48	8 34·5
Sat	28			3rd Sh. E. 3rd Tr. I. 3rd Tr. E.	9 53 11 46 14 20	8 30·6
Sun	29	7 21	Occultation reappearance of B.A.C. 1651 (6½)	2nd Ec. D. 2nd Oc. R.	10 13 9 15 5	8 26·6
Mon	30	5	Conjunction of Moon and Jupiter 3° 0′ N.			8 22·7
Tues	31		Saturn's Ring: Major axis=43″·85 Minor axis=18″·04	2nd Tr. E. 2nd Sh. I.	9 13 17 54	8 18·8
NOV. Wed	1			1st Ec. D.	15 4 30	8 14·8

Book received.—Madeira Meteorologie. By C. Piazzi Smyth. Edinburgh: David Douglas. 1882.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June, 1882.
Barneby, T.

To Dec., 1882.
Remington, Major

To March, 1883.
Harrild, R. E.
Potter, Rev. T. J.

To April, 1883.
Bookwalter, F. M.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications, Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson, 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

NOTICE.

It has been suggested to us that a General Index of our first Twenty Volumes would be both useful and agreeable to our Subscribers. Such an index could be supplied to Subscribers for 3s. 6d. per copy, in advance, provided a sufficient number of copies were ordered. If this suggestion meets with the necessary support of our Subscribers, we shall be glad to put the matter in hand. **An immediate application is requested.**

The Astronomical Register.

No. 239. NOVEMBER. 1882.

OBSERVATORIES OF EUROPE.

(Continued from page 227.)

HELSINGFORS. The observatory is situated to the south, on an elevation which commands the city and the sea. The general arrangement is similar to the observatory of Pulkova. There are three domes above the building; the middle one contains an equatorial of 7-in., by Utzschneider and Fraunhofer, with micrometer. The director, M. Sundell, professor of physics at the university, observes the solar protuberances with this instrument and a spectroscope of Schröder. In the western dome is a heliometer by Fraunhofer of 3-in. In the eastern there is nothing. In the meridian hall to the west is a 4-in. meridian-circle by Utzschneider and Fraunhofer, with a circle, reversible, read by a single microscope. There is a meridian mark to the S. and a collimator on the N. M. Krüger, now at Gotha, the director of the observatory of Helsingfors, had commenced with this instrument the observation of a zone of stars. It is used at present for finding the time. A clock by Tiede, in the central part of the building, protected from sudden variations of temperature, is in connection with another for meridian observations. In a room on the south is a telescope employed as a prime vertical. The observatory gives the time daily to the port, which announces it to the city by a cannon. Passing from Helsingfors to Stockholm. during a stay of some hours at Abo, we visited the observatory which was the scene of the first labours of Argelander. At the present time nothing remains of it but the name.

STOCKHOLM. Under the wise and active direction of M. Gyldén, this observatory daily acquires more importance. An equatorial of 7-in. and 10-ft. focal distance, by M. M. Repsold, especially designed for the determination of the parallax of stars, has lately been set up with exceptional conditions of stability. The cylindrical stand of cast-iron rests on massive stone work of great size, protected from variations of temperature by a double casing, also of stone. Observations are made with a chronograph. The dome, of cylindrical form, is of wood, with a canvas covering inside. It revolves by a mechanism similar to that of the domes of Vienna and Potsdam, the opening being the whole length of a meridian. With this instrument M. Gyldén has undertaken the determination of the parallax of 18 stars, 61 Cygni amongst them. This work will soon be ended. The meridian-circle is an old instrument by Reichenbach, having the divided circle movable, with another fixed one, on which only the four degrees at the extremities of the two perpendiculars under the four microscopes are divided to minutes. This is the idea of Hansen under another form. Observations are made with the chronograph. A point fixed at a distance of about three miles on a hill to the south is used from time to time, instead of a regular meridian mark and collimators. The instrumental constants are always deduced from the observations themselves of the stars. Observations of the nadir are made regularly, the images are generally excellent, and without tremors. The instrument is reversible, and the objective and the eye-piece can change places. With this circle has been undertaken the observation of stars to the eighth magnitude, between the pole and 45° polar distance. Each star is observed four times in both positions of the instrument, and interchanging the objective and the eye-piece for each position. The stars of comparison are those of the catalogue of Auwers, and another prepared by M. Gyldén for the special purpose. M. Gyldén has already been able to conclude the proper motions of a certain number of these stars by comparing old observations. The chronograph by Theorell, of Stockholm, marks seconds and five seconds; the standard clock is also by Theorell. It is of small dimensions and secured, for constant temperature and pressure, under the receiver of a pneumatic machine. It has performed since two years in the most satisfactory manner. We may also note a small telescope sufficiently powerful to observe the pole star in the daytime, and with which M. Gyldén makes observations of the sun. A similar telescope will be mounted for declinations. M. Gyldén thinks that with small instruments the determination of the equinox and the obliquity of the ecliptic can be effected with greater precision than with large instruments.

Upsala. This observatory is under repair, and its principal instrument, an equatorial by Steinheil, is dismounted, but will soon be set up again for resuming observations. The director, M. Schultz, is known for his observations of Mars, the small planets and comets, and of 500 nebulæ, the catalogue of which was published in 1874. He also published a treatise on astronomy in 1879. Since 1878 the meteorological service, though still carried on in the same building, has been placed under the direction of M. Hildebrand Hildebrandsson. Meteorological observations have been carried on at Upsala uninterruptedly since 1722. Begun by Ericus Burman, they were continued by A. Celsius, who discovered, in 1741, the influence of auroras on the compass. In 1833, M. G. Svanberg organised regular magnetic observations with instruments of Gauss, which were continued till 1863, in a great tower on the north part of the Château Royal, given to the observatory by the king, Charles John. The results appeared in the great publications of Gauss. Since 1863 only occasional observations of absolute determinations have been made in a small magnetic observatory constructed by Angström. In 1865 an arrangement was made for hourly meteorological observations, night and day, which, under the direction of M. Rubenson, were carried on with great exactness till 1868, when a self-registering instrument by Theorell was set up. These observations have been published. In 1871, M. Hildebrandsson, whose energy is inexhaustible, organised, in conjunction with the societies of economic agriculture that exist in each province of the kingdom, a study of storms of the same kind as has been set on foot so successfully in France by Le Verrier. Since 1873 the phenomena relative to the animal and vegetable kingdoms have been included. The number of the stations is about 400. The results of these observations appear in various scientific journals, and circulars are sent to different observers. M. Hildebrandsson is desirous of obtaining for his meteorological observatory a separate location from the astronomical observatory, and there is no doubt that, with his indefatigable zeal for science, he will soon succeed in obtaining from the government the funds requisite for this reasonable object.

Lund. The actual observatory was built in 1866, on a piece of ground belonging to the university, on the S.W. of the city. It is a square edifice, surmounted by a dome, flanked by four pavilions, each of the same size. The meridian-room is on the west wing. The walls and roof have a double covering of wood, and the roof is, besides, covered with sheet iron. The opening is about 3½-ft. wide. This room contains a meridian-circle by M. M. Repsold, carried by two pillars of concrete which rest on

piers of masonry. The telescope is 6·3-in. aperture, and $7\frac{1}{2}$-ft. focal length. There are two circles symmetrically placed, only one of which is divided, but the limb has two divisions, one to every 10′ for setting, the other to every 2′ for readings. It has four microscopes with two others auxiliary for the study of the divisions. The instrument is reversible; a collimator is placed to the S., and two meridian marks are to be fixed hereafter. A bath of quicksilver is used for observations of the nadir, and another for observations by reflection. Light for the field, for the wires, and for the circle divisions is given by a petroleum lamp, and to avoid the heating of the instrument, a glass vessel with parallel sides is interposed, filled in the summer with water, and a mixture of water and glycerine in winter. Four large mirrors behind the lamp send light on four small ones fixed on the microscope supports, for the reading of the divided circle. The field and the wires are illumined by a lense before the lamp, which makes the rays converge through the pivots. A large glazed cage, moveable on rails from east to west, covers the instrument when not in use, and protects it from dust and blows. Observations are made with the chronograph. The standard clock in the central gallery beneath the great dome is by Tiede, of Berlin. A good clock by Kessels, of Altona, is in the meridian-room. The flexure of the telescope and the errors of division were determined by M. Linstedt, who is now attached to the observatory of Dorpat. The astronomical flexure is 0″·57 at the horizon. The correction of the mean of the readings of two microscopes is at the most 0″·9. The latitude of the observatory was found by M. Linstedt by observations of the pole star, direct and by reflection, in the two positions of the objective at the extremities of the tube.

M. Dunér, assistant of M. Engström, is at present observing with the meridian-circle the zone of the *Durchmusterung*, comprised between 35° and 40° N. Decl., a part of which had been already observed by M. Linstedt. So far, there have been made 14,000 observations of 7,000 stars, there will be 11,000 in all. In the hall on the east is a meridian telescope for the instruction of students. The central dome contains an equatorial 9-in. aperture and 13-ft. focal length, by Merz and Jünger. The dome is cylindrical, with double covering of wood, and rolls on balls united by cross-pieces. The opening extends only on one side of the zenith for one half of the dome. The instrument has a base of concrete, which rests on a brick pillar. A system of levers along the tube is designed to obviate flexure. A particular description of the micrometer and clock-work movement has been given by M. Dunér in his fine work on the double stars which he

has observed with this instrument. The director of the observatory, M. Möller,* has made many observations of comets and planets with this equatorial. M. Visicander has likewise observed with it. M. Dunér has undertaken since 1878, with the same instrument and a spectroscope by Merz, the study of the spectra of double stars, the first results of which have appeared in the *Astronomische Nachrichten.* The observatory also possesses a small equatorial, with objective of Gauss, 4·2-in. aperture, and 3½-ft. focal length, placed in a little house on the south of the garden, with which the indefatigable M. Dunér observes the variable stars.

COPENHAGEN. The observatory is constructed on the same general plan as that of Pulkova. In the centre is a dome with an equatorial; on the east and west sides are the meridian-rooms, and the dwelling-houses are at the two extremities; a hall on the south is destined for a prime vertical instrument. In the hall on the east a meridian telescope, 6·3-in. aperture and 8½-ft. focal length, enables differential measurements of the two co-ordinates of stars to be rapidly made. The micrometer is in electric communication with a chronograph, so that the two co-ordinates can be registered simultaneously. The instrument has been constructed by M. Jurgensen, of Copenhagen, under the instructions of M. Thiele, the learned director of the observatory.† In the hall to the west is a circle by Pistor and Martins, the telescope 4·7-in. aperture, and 6½-ft. focal length. One of the circles is divided every 10′ for setting, the other every 2′ for readings; the latter is read by four microscopes. There is a fixed bath of quicksilver for the nadir, but no meridian marks. Observations are made with the chronograph. The clock was made by M. Jurgensen. A divided plate, fixed in one of the pivots, and a microscope in face of it on the pillar, enable the pivots to be examined. It is with this instrument that M. Schjellerup observed the stars of his catalogue. The central dome, of spherical form, is covered with sheet iron and double canvas inside. It is opened only on one side of the zenith. The telescope of the equatorial is 10½-in. aperture and 16-ft. focal length. The tube is of wood. It was made by Merz and Jünger. It is this instrument that d'Arrest used for his measurements of nebulæ, and his work on stellar

* M. Möller has been some time engaged with the theory of the planet Pandora, by Hansen's method. It has been necessary to calculate the terms of the third order relative to the masses.

† M. Thiele is known by his important work on double stars, with a discussion of the methods of Herschel, Savary, and Encke, for the calculations of the orbits, which, with some modifications, he has applied to γ Virginis. More recently he has brought out a paper on Castor.

spectroscopy. M. Pechüle, formerly at Hamburgh, studies with it the spectra of the red stars of Birmingham's catalogue.

Copenhagen has a meteorological bureau, directed by M. Hoffmeyer, who collects and publishes the observations of various stations. Observations are published every twenty days. This bureau also publishes meteorological bulletins twice a day. M. Hoffmeyer has written an interesting work on observations made all over the globe during the years 1874-75 and 1876.

Hamburg. The observatory belongs to the city, and is directed by M. Rümker. There are two meridian instruments: a meridian telescope of 4-in. by Repsold, and a meridian-circle also by him, with telescope 4-in. aperture and $5\frac{1}{4}$-ft. focal length. The two circles, divided every $2'$ and 3-ft. 3-in. in diameter, are each read by four microscopes. With this instrument M. C. Schrader observes a zone comprised between $+80°$ and $+81°$ of Decl. A thousand stars have been hitherto observed, each of them three times. There is a meridian mark to the south, and a collimator on the north. The observations are made with the chronograph. The observatory also possesses an equatorial 9·8-in. aperture and 10-ft. focal length; the objective is by Schrœder and the mechanical part by Repsold. Between the objective and eye-piece another lense is placed to enlarge the field and improve the images. It was made after the ideas of Hansen, in order to determine the absolute positions of stars under conditions of great stability. The hour and declination circles are divided to every $2'$, and each is read by two microscopes. M. Rümker observes with this instrument comets, planets, and nebulæ. M. Helmert, now professor at Aix-la-Chapelle, has used it for an interesting work on the cluster in the Shield of Sobieski (Q. M. 24 ?), and has compared his observations with those made by Lamont on the same.

In a building near the observatory, M. Bœdiker has charge of marine chronometers on trial. The trial of each chronometer lasts about three months, during which it is subjected to temperatures of $+5°$ to $+30°$ C., being left in the same temperature ten days. The best chronometers receive a premium from the State, which purchases a certain number. Another important institution of this kind exists at Wilhelmshaven, and one less complete at the observatory of Kiel. The meteorological observatory of Hamburgh, directed by M. Neumayer, publishes the observations of 50 maritime stations. It possesses the valuable library of Dove. Its present site is provisionary; before long it is to be transferred to a fine and large edifice, which is being constructed by the German Government at a great cost, near the existing one, upon a height which commands the port.

We several times visited the important workshops of M. M.

Repsold, who with the utmost kindness always gave us every information we wished for. We saw there the 14-in. equatorial of Pulkova, entirely renovated as to its mechanical part. The hollow cylindrical pillar of cast-iron that forms the stand is much less massive than in our equatorials. Greater facilities are thus obtained for the management of the telescope, and the motions of the observer himself,—considerable advantages, provided they are not obtained at the expense of stability. The tube is formed of sheets of steel riveted together, the thickness diminishing towards the extremities of the tube in such a manner as to preserve equilibrium and equality of flexure. The clockwork movement is in the stand, and the circle of declination near the tube of the telescope. There are various improvements in the micrometer. A petroleum lamp near the eyepiece, within reach of the observer, throws light into the finder, which then passes through a lense, and is converged on an elliptic mirror of metal, pierced in the middle, and making an angle of 45° between the finder and the telescope. One part of the light from this mirror is made to illumine the circles, a second part the field, and a third part is contrived so as to fall on a bevel arranged in the micrometer for illuminating the wires. A faint portion of this light is reflected by two prisms on the divisions of the position-circle, and another portion illumines the drum of the micrometer screw, by means of a prism and two mirrors. The position-circle is read by two magnifying glasses furnished with glass plates, divided by photography. In the meridian-circles, from the house of Repsold, the field is illumined by a convex mirror, glued on the centre of the interior surface of the flint glass. The illumination of the wires in equatorials by means of electric light has been attempted without success. The instruments in course of construction in the workshops of M. M. Repsold are the following: the equatorial of Pulkova renovated; an equatorial of 18-in., destined for the observatory of Milan; a heliograph for Potsdam; a heliometer of 6-in.; a meridian-circle for America; and a meridian telescope for Japan.

Kiel. The observatory has been without a director since the death of Peters, whose son has provisionally succeeded him. It is about 2½ miles to the north of the city, on a height which overlooks the port. There is a meridian-circle by Reichenbach, like the one at Stockholm, the divided circle being moveable in a fixed one. The telescope can be reversed, and there are two meridian marks. M. Schumacher observes the stars between the pole and +80° Decl. The observations can be made chronographically. The chronograph is by Knoblich, of Altona, the clock by Jurgensen, of Copenhagen. There is also a clock by

Knoblich with barometric compensation, and another good one by Breguet. The 8-in. equatorial by Steinheil is used by M. W. Peters for the observation of faint nebulæ; the finer ones are observed with an equatorial of Repsold, by M. Lampf. A new equatorial for photographic observations will be shortly mounted.

Bonn. The observatory dates from 1843. It is a single block of building with a central dome, two others on the east and two on the west, separated from the central dome by two meridian rooms, and a room for a prime vertical instrument. In one of the eastern domes is an equatorial by Schrœder, 6-in. aperture, with wooden tube and no clockwork, with which M. Schönfield, well-known for his many labours and particularly for his catalogues of variable stars and nebulæ, and formerly assistant of Argelander, continues the catalogue of that distinguished astronomer for the regions between 2° and 23° S. Decl. M. Schönfield observes with an eye-piece furnished with thick wires, similar to that employed by M. M. Henry for their ecliptic charts. He remains in total darkness, and calls out the passage of the star by the number representing its magnitude, makes himself a note of the magnitude if it lies between two whole magnitudes, and inscribes the declinations on a paper fastened on a board pierced with large holes regularly disposed, by which he can write without light; at the same time an assistant beneath the floor, with a clock in front of him, writes down the time of the passage and the magnitude of the star. For viewing faint stars, M. Schönfield has often found it of great advantage to make use of coloured glasses before the light which illumines the field. This extensive work, only begun in 1876, is now far advanced. M. Schönfield has already made 300,000 observations, almost always observing each star three times, or at least twice. The total number of stars to be observed is about 130,000, a relatively large number, considering that the extent of this region is scarcely above one-third (0·34) of the extent of the zones of Argelander. M. Schönfield is preparing by degrees charts which will be the continuation and the complement of those of Argelander.

There is also observed at Bonn a zone of the *Bonner Durchmusterung* from +40° to +50°, or double the extent usually entrusted to each observatory. The observations are made by M. Deichmuller with a meridian-circle of Pistor and Martin's of 4·3-in., in the east hall; each star is observed in both positions of the instrument. The clock is by Repsold with barometrical compensation. In the prime vertical room is a meridian telescope, the axis of which carries a vernier which has a range of about 12° in a fixed circle, which was employed by Argelander for certain northern regions. In the central dome is a heliometer by Utzschneider of 6-in., with

which MM. Winnecke and Krüger, who with M. Schönfield were pupils of Argelander at Bonn, have made observations of stellar parallaxes. A meridian-circle by M. M. Repsold, on the model of those of Strasburg and Brussels, has arrived, and will soon be placed in one of the western halls at present occupied by a small universal instrument.

LEYDEN. The observatory was built in 1860. It has a dome in the centre with an equatorial, two halls on each side east and west, and the dwelling-houses at the two ends. The central building is continued a little to the south, and is terminated by a second dome, rather smaller than the preceding, and of less height. On the N.W. an isolated pavilion contains a 6-in. equatorial, which came from the old observatory. A meridian-circle by Pistor and Martins, with a telescope 5¼-in. aperture, and nearly nine feet focal length, has been placed since 1861 by Kaiser, in the west hall. Since that time it has received many additions and modifications, especially in 1874, and has been most completely studied, so that it is now one of the best mounted meridian-circles in existence. The stone piers are covered with felt, above which, with a space between, is another covering of zinc. Before this the presence only of the assistant, who read one of the microscopes, was enough to occasion a displacement of the zero point in the divided circle, which kept on gradually increasing. This was when there was no interval between the felt and the zinc. The objective and eye-piece can be interchanged. The two circles, about 3½-ft. diameter, are graduated every 5′, and each is read by four microscopes. The micrometer is furnished with a great number of fixed wires in R.A., for chronographic observations, and one moveable and several fixed in Decl. The light is given by two petroleum lamps, and sent by two prisms on a small convex mirror glued to the interior surface of the flint-glass for illumination of the field, and upon a system of four prisms in the micrometer, to show bright wires on a dark field. A screen in one of the cones of the axis serves to regulate the intensity of the light. Four lenses placed a little in front of each lamp illumine the drums of the microscopes. A glazed frame, moveable on rails, covers the instrument when not in use. There are two meridian marks of about 330 and 210-ft. focal distance, illumined in the manner of those at Pulkova. A circular vessel of amalgamated copper, spread over with a thin layer of mercury, when surrounded by a cylinder of pasteboard, affords images of remarkable clearness and fixity. The I. and II. volumes of the *Annals* of the observatory contain an account of the determination of flexure and the study of the pivots, by M. Bakhuyzen. For a determinate position of the telescope there is found a difference

between the readings of the circles which amounts to $0''\cdot3$ or $0''\cdot4$, sometimes in one direction, sometimes in another. Observations are made with a chronograph and a clock by Knoblich. The standard clock is by Hohwü, of Amsterdam, in the meridian-hall, enclosed in a double frame of wood. There is an apparatus for the study of personal equations. Two excellent plane mirrors, the workmanship of M. Martin, which form part of this, were found by M. Bakhuyzen to be slightly spherical; the radius of one being 8·7 miles, and of the other 12·4 miles.

The meridian-circle has been sometimes employed in the observation of 90 circumpolar stars, of not less than seventh magnitude, and not more than $6^\circ\cdot5$ from the pole. The complete observation of a star involves sixteen operations. This important work, temporarily interrupted by the determinations of the difference of longitude between Leyden and Greenwich, by M. Bakhuyzen and his brother, who is first astronomer at the observatory, will be resumed forthwith. M. Bakhuyzen has also undertaken, in concert with M. Gill, director of the observatory at the Cape, the formation of a catalogue of about 400 stars, some of which, near the zenith of one observatory and the horizon of the other, will enable refraction to be investigated at a low altitude. There are other instruments in the observatory. In the south dome is an old equatorial, by Utzschneider and Fraunhofer, with wooden tube and stand, serving for current observations of comets and planets. In the north dome there is a 7-in. equatorial by Merz, with tube of wood and clockwork by Eichens, to which a double-image micrometer of Airy can be adopted. It has served for the measurements of double stars and diameters of planets, which have been published in Vol. III. of the *Annals*, and recently M. Bakhuyzen has taken with it some measurements of the diameter of Mars. A spacious hall between the two equatorials contains a large collection of instruments, amongst which are an apparatus devised by Kaiser for determining personal equations, a comet-seeker by Merz, a small instrument by Repsold, 2-in. aperture, with which M. Bakhuyzen proposes to observe in different azimuths the stars, which in conjunction with M. Gill will be observed on the meridian. For this purpose the instrument will be placed in the detached dome on the N.W., and the place will be alternately occupied by a heliometer of Merz, destined for observations on the libration of the moon. In the same dome is also a comet-seeker by Steinheil. We have yet to mention an instrument by Repsold, devised by M. Bakhuyzen, originally intended for measuring the photographs of the transit of Venus, and which can be usefully employed in the study of screws, and especially of the screw of Airy's double-image micrometer.

Vol. I. of the *Annals* has a complete description of the observatory, its instruments, and the observations with the meridian-circle. Vols. II. and III. positions of stars for determination of latitude and longitude. All three appeared under the name of Kaiser, then director of the observatory. Vol. IV., published at the end of 1872 by the new director, embraces the first part of the zone of the *Durchmusterung* of Argelander, extending from $+29^{\circ}.50'$ to $+35^{\circ}.10'$, and will shortly be followed by other volumes. Vol. V. will give the continuation and end of the zone. Vol. VI. the reduction of the declination observations with the meridian-circle, directly and by reflection in the two positions of the instrument. The right ascensions will be subsequently published. The observations of the polar distances of the sun, in a work relative to the inclination of the ecliptic, by the brother of M. Bakhuyzen, have already been reduced (Leyden, 1879), and the observations of α and δ Ursæ Minoris have appeared at intervals.

Brussels. The observatory was built in 1830. It consists of a single edifice divided into three parts. The west wing is inhabited by the director; the meridian-hall is in the centre; the bureau, library, and various instruments are in the east portion of the building. The meridian-hall contains a telescope by Gambey of 6·3-in. aperture and nearly eight feet focal length, and a mural circle by Troughton 4-ft. 3-in. diameter. Fundamental and moon-culminating stars are observed, and the mural circle is employed for a renewed determination of latitude. M. Lagrange, astronomer of the observatory, the author of several works on physical astronomy, studies the flexure of the telescope by Bessel's method. The clock of the meridian-circle is by Kessels, of Altona. Above the building on the east there has been placed since three years an equatorial by Cooke, of York, with objective by Merz of 4-in., with micrometer and clockwork. M. Niesten observes with it the phenomena of Jupiter's satellites, and makes measurements of double stars and drawings of various planets. A young astronomical pupil has made with an equatorial numerous sketches of the moon. Above the western building is an equatorial by Troughton and Simms, 3·5-in. aperture, employed for Jupiter's satellites. On the west of the edifice M. Fievez uses a spectroscope of Young, with 10 prisms made by Grubb, a spectroscope of Christie by Hilger, of London, and a grating by Rutherford with 17,735 lines to an inch. A new meridian-circle, furnished by the house of Repsold, nearly resembling the circles of Strasburg and Bonn, is provisionally placed in a hut in the middle of the garden. The telescope is 5·9-in. aperture and 6-ft. 2-in. focal length. The axis carries two divided circles nearly 2-ft. in diameter. One is divided to 2′, the other to degrees only, except

at the extremities of the perpendicular diameters, where 4° are divided to 2′. The circles are read by four microscopes. The micrometer has a great number of moveable vertical wires for chronographic observations. A chronograph has been ordered from Dent. There are collimators N. and S.; the pivots are about 4-in. diameter. In one is fixed an objective, and in the other in its focus a glass plate, with a small ring in its centre, traced by photography. In this manner the axis becomes itself a collimator, on which are directed two telescopes furnished with microscopes on pillars, fixed in the E. and W. line, so that the values and variations of the indications of the level, the rectification of the position of the axis, and the examination of the pivots are obtainable. M. Goemans is examining the errors of division; the circle will not be definitely set up till the new observatory is ready, which the extension of the city in the neighbourhood of the present one and insufficiency of room, render more and more necessary. The mounting of an equatorial of 15-in., with objective by Merz, constructed by Cooke, is postponed on the same account; meanwhile it is not unpacked for want of space.

The publications of the observatory are actively carried on. Vol. I. of the new series contains the uranometria of the two hemispheres, giving all stars visible to the naked eye to the sixth magnitude, and a valuable collection of the constants of astronomy. Vols. II. and III. have the observations of 10,000 stars, having, or supposed to have, a notable proper motion. Vol. IV. will contain the catalogue. In conjunction with M. Lancaster, librarian of the establishment, M. Houzeau has undertaken the publication in three volumes of a General Bibliography of Astronomy. The second volume contains references to memoirs of academies, learned societies, and articles in journals, and will appear first. Then will follow Vol. I., devoted to separate publications, and finally Vol. III., relative to observations.

Magnetism and meteorology occupy an important place in the labours of the observatory. There are many excellent instruments, self-registering and others. Amongst the former an electric meteorograph, which with a single marker traces the curves of the thermometer, barometer, and the direction and force of the wind, which can be reproduced with great ease for a considerable number of copies. It was devised by Rysselberghe, meteorologist of the observatory, and constructed by Schubart, of Gand. It has been in operation since the beginning of 1879. Eight others of the same kind have been made and distributed amongst various establishments. There is also a self-registering pluviometer, on the same principle as that of M. Hervé Mangon, which shows the duration, commencement, and end of the rainfall.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

SATURN'S RING.

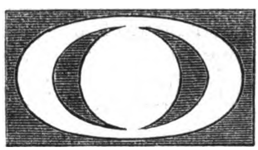
Sir,—You will probably have seen in *The Observatory* for the current month, as well as in *Knowledge*, Vol. II., No. 48, that an enquiry has been made respecting the amount of credit which is due to the Messrs. Ball for their supposed discovery of the primary division in the ring of Saturn. As it is possible that some of your readers may not have seen some of these papers, I thought the following statement might be of interest to them. It is a somewhat extraordinary circumstance that Mr. Wm. Ball and his brother, Dr. Ball, should have been credited during the last forty or fifty years with the honour of being the discoverers of this feature in Saturn's ring, and which has been styled by many eminent astronomers, up to the present year, as "Ball's division."

In the year 1880, it occurred to W. T. Lynn, Esq., F.R.A.S., to refer to the original communication of the Messrs. Ball to the Royal Society. In doing so he found no positive conclusion could be drawn about their assumed discovery without their drawing, which, for some unaccountable reason, was not given in three copies of Vol. I. of *Phil. Trans.* which he had examined. Mr. Lynn did not prosecute this enquiry any further until he paid me a visit on Sept. 15, 1882, when we discussed the subject, and I stated to him that for many years I had been impressed with the idea that Cassini—not Ball—had discovered the primary division in Saturn's ring, and I showed him Lowthorp's "Abridgement" of the early volumes of the *Phil. Trans.*, as my authority for the supposition. In this volume Mr. Lynn found Ball's drawing of the planet, which referred to the observation of Oct. 13th, 1665. The following is a verbatim copy of the original paper in the *Phil. Trans.*, which was as follows:

"This observation was made by Mr. William Ball, accompanied by his brother, Dr. Ball, Oct. 13, 1665, at Mainhead, near Exeter, in Devonshire, with a very good telescope near 38 feet long, and a double eyeglass, as the observer himself takes notice, adding that he never saw that Planet more distinct. The observation is represented by figure 3, concerning which the Author saith in his letter to a friend as follows: This appeared to me, the present

figure of Saturn, somewhat otherwise than I expected, thinking it would have been decreasing, but I found it full as ever, and a little hollow above and below. Whereupon the Person to whom notice was sent hereof, examining this shape, hath by letters desired the worthy Author of the System of this Planet, that he would now attentively consider the present figure of his anses or ring, to see whether the appearance be to him as in this figure, and consequently whether he there meets with nothing, that may make him think, that it is not *one* body of a *circular figure* that embraces his *disk* but *two*. And to the end that other curious men, in other places might be engaged to joyn their observations with him, to see whether they can find the like appearance to that represented here, especially such Notches and Hollownesses as at A. B. it was thought fit to insert here this newly related Account."

It is not stated who the "Person" was to whom this letter was sent, but in all probability it was Huyghens or Hooke. The annexed copy of Ball's drawing I have copied from Lowthorp.



Now, in this plate, not the slightest trace of any division in the ring is to be seen, and I consider that a very great misapprehension has arisen as to the precise meaning of the following words: "Whether he there meets with nothing that may make him think that it is not *one* body of a circular figure that embraces his disc but *two*." I am disposed to think that he meant the two ansæ; for what reference could "Notches and Hollownesses" have to a *line* of division on the ring?

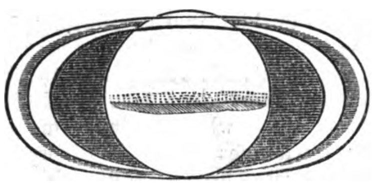
The next engraving, in order of date, is Hooke's, of which the following is a representation—

It refers to an observation by him on June 29, 1666, viz.:— "Between 11 and 12 at night I observed the body of Saturn

through a 60 foot telescope, and found it *exactly* of the shape represented in the figure. The ring appeared of a somewhat brighter light than the body; and the black lines *a a* crossing the ring, and *b b* crossing the body (whether shadows or not I dispute not) were plainly visible; whence I could manifestly see that the southernmost part of the ring was on this side of the body, and the northern part behind or covered by the body."

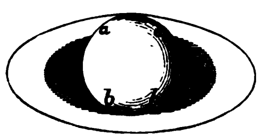
In Hooke's drawing no trace of a division in the ring is perceptible, which would surely have been the case had he supposed that Ball had really made such a very important discovery. The lines *a a b b* which he describes as crossing the ring are fully accounted for in the explanation of the plate, and can only be intended to show his ideas as to the shadow of the planet falling upon the ring, and that of the ring upon the planet.

The next engraving is by Hevelius, dated August, 1675.



It is interesting, as showing how much better he had been enabled to inform himself of the relatively true form of Saturn and its ring. Had Ball really discovered the division Hevelius was not a man who would have omitted, either to satisfy himself of the truth of such discovery or to have omitted its insertion into his own drawing upon its confirmation. I must, therefore, maintain that, up to the year 1675, the division in Saturn's ring had not been discovered.

The next and most important engraving relating to this enquiry is by Cassini, and bears date August, 1676.



We have here, for the first time, an actual drawing of the division in the ring, and his communication to the Royal Society runs thus—

"Ex Schemate Saturni à Hevelio ante annum observato

video, cum Telescopis nostris longè inferioribus, uti. Tunc enim temporis (ut et nunc Aug., 1676,) cernebatur nobis in Saturni Globo Zona subobscura, pauló Australior centro, instar Zonarum Jovialium. Deinde latitudo Annuli dividebatur bifariam, Lineâ obscurâ apparenter Ellipticâ revera Circulari quasi in duos annulos concentricos, quorum interior exteriori lucidior erat. Hanc phasim statim post emersionem Saturni è Solaribus radiis per annum usque ad ejus immersionem conspexi; primo quidem, Telescopio Pedum 35, deindè minori, Pedum 20."

The above appears to me a plain and decided announcement of the discovery, and makes no allusion whatever to any previous observation of the kind.

A confirmation of Cassini's discovery may be found in Dr. Smith's Optics, 4to, 1738, Vol. II., p. 440, from which the following is an extract:—

"In the year 1676, after Saturn had emerged from the Sun's rays, Sig. Cassini saw him in the morning twilight with a darkish belt upon his globe, parallel to the long axis of his ring, as usual. But what was most remarkable the broadside of the ring was bisected quite round by a dark elliptical line, dividing it, as it were, into two rings, of which the inner ring appeared brighter than the outer one, with nearly the like difference in brightness, as between that of silver polished and unpolished; which, *though never observed before*,* was seen many times after, with tubes of 34 and 20 feet; and more evidently in the twilight, or moonlight, than in a darker sky."

I am informed that there are other astronomical works which attribute to Cassini the discovery of the division in Saturn's ring; but during the present century, Kitchener in 1825, Smyth in 1844, Hind in 1852, Proctor in his "Saturn," p. 49, Breen in "Planetary Worlds," p. 217, &c., all repeat the story of the brothers Ball having discovered this feature in the ring of Saturn. I have made this inquiry in the hope of elucidating the truth, and of recovering for Cassini the honour which would appear to be due to him.

I beg to remain, Sir, your obedient servant,

The Observatory, Crowborough: C. LEESON PRINCE.
Oct. 6, 1882.

P.S.—I may perhaps mention that a few days after my discussion with Mr. Lynn upon this subject, I had the pleasure of an interview with Capt. Noble, F.R.A.S., of Forest Lodge, Maresfield, to whom I explained the nature of this discussion and its

* The italics are mine.

result. It is satisfactory to find, by two letters which this well-known practical astronomer has written to a contemporary that, after taking time fully to consider the matter, he has arrived at the same conclusion with Mr. Lynn and myself.

VARIABLE STAR?

Sir,—I beg to call the attention of observers who are interested in stellar variation, and are provided with telescopes of sufficient aperture, to a minute star lying in the general mass of the light of the great Andromeda Nebula, *p* the nucleus a little *s*, at a distance according to d'Arrest of rather more than 11s. of R.A. He gives it 11 or 12 mag. of his scale, which I believe is that of Argelander, equal to about 14 or 15 of Smyth, but I think, after making due allowance for the uncertainty of these small magnitudes, that I have more than once seen it of 12 mag. The first time that I observed it, long before I became acquainted with d'Arrest's admirable and interesting catalogue, was on Oct. 27, 1869, when I was struck by its appearance, as of that of a previously unnoticed object. I have entered that it "certainly had quite an unfamiliar aspect to me." The following night, the sky being more transparent, but definition worse, and the light between Bond's canals being very distinct, though I had seen the canals themselves much better, the star, though very distinct, was less obvious. Nov. 6, the star was well seen. 1876, Jan. 15, it was very obvious, about 12 or 13 mag., "about 0·5 mag. below star N. of nucleus, less than twice as distant from it." 1878, Oct. 23, no trace of the little star, but the sky was not very dark, and I was in haste. Nov. 2, it was readily visible. Nov. 5, ditto. 1881, Nov. 14, blotty definition; star very faint. Dec. 23, not obvious at first; may be 14 mag. 1882, Jan. 6, sky not very dark; one glimpse of it only fancied. The instrument employed throughout was an excellent 9⅓-in. silvered speculum by With, usually with a low power.

I scarcely know whether these slight differences of visibility in an object so easily obscured by haze ought to be considered as amounting to suspected variation, but they may possibly be worthy of future attention. Of the second star N. of the nucleus, mentioned Jan. 15, 1876, I find no other notice, nor is it mentioned by d'Arrest, and I had forgotten my own observation of it, so that I did not look for it when I examined the nebula on three occasions last winter, and I have as yet had no opportunity during the present season. It may, however, be deserving of notice.

Hardwick Vicarage, Hay: T. W. WEBB.

Oct. 18, 1882.

JUPITER'S RED SPOT.

Sir,—Although the red spot on Jupiter has lately become very much fainter, it is by no means certain that its early entire disappearance may be expected, as suggested by Mr. W. F. Denning on p. 235, No. 238 of the *Astronomical Register*. The early observations seem to lead us strongly to infer that for some years the spot was visible as a somewhat faint and changeable object, before it became such a very conspicuous feature, and last year it became very much fainter, though it again returned to nearly its former prominence. Its dim appearance at present, moreover, has struck me strongly as being due to mist or cloud, through which it is still faintly visible. The spot itself remains perfectly defined; the darker spot on the following tip, which has been visible since 1880, being quite apparent. I therefore think that its present faintness will very probably prove only temporary, and that in a few months it may again become one of the most prominent features of this planet.

In case the spot should soon entirely disappear, attention should even then be most carefully directed to its probable position whenever practicable, at least for several years to come, in order, if possible, to obtain even some faint evidence of its existence, and the early history of the spot suggests that, in such a case, such evidence will be forthcoming. The appearance of the spot now, when central, is almost exactly the same as it was last year when it was near one of the limbs, and as in this latter position it was undoubtedly seen through a much greater thickness of vapour, considerable support is afforded to the suggestion that the present faintness of the spot may be due to a similar cause.

West Brighton:
Oct. 14, 1882.

Yours faithfully,
A. STANLEY WILLIAMS.

LUNAR WORK FOR NOVEMBER, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

A very interesting article by Dr. Klein on the volcanic formations in the moon has appeared in Petermann's *Mittheilungen*, of which a translation has been given in the *Observatory* for September last. In it the author, following Neison, points out that the analogues of our terrestrial volcanoes are not the formations commonly called Craters or Ring-mountains, but rather those steep conical hills known among selenographers as "crater-cones." These vary in size, from one half to two or three English miles in diameter, having a precipitous funnel-shaped central hollow, scarcely half the breadth of the hills themselves.

This central chasm can only be seen when the altitude of the sun is low; when it is high the cones appear in powerful instruments as minute white spots. They have been seen on the floors of *Fracastorius* and *Plato*, and also in the interior of *Stadius*.

But Dr. Klein is of opinion that another class of formations, which have been very little studied up to the present time, are still more exactly analogous to terrestrial volcanoes. These are bright points surrounded by a dark grey nimbus, and are very rare, so that only five are certainly known at present.

It is well, therefore, to call attention to the following objects, which are considered to present the true type :—

1. That close to *Copernicus*, in a south-westerly direction towards *Gambart*.

2. A dark patch south-west of *Theophilus*, noted by Schmidt in Jan., 1851. On this Klein saw a crater with a clear white cavity, which, at a certain distance on the outside, was surrounded by a ring of smoky-grey material.

3. A dark patch very similar to the above, but not so large, and near it in the direction of *Theophilus;* on this Klein also saw a crater. In the position of this and the preceding object, Miss Ashley has several times seen a number of minute craters, two being larger than the rest, and one in the southern of the two patches being more conspicuous than the others (see *Lunar Work*, p. 192). She seems to have seen in each patch a principal one and a number of minute points around it.

4. A similar object southwards from *Hyginus* (*Hyginus m ?*). In this, too, there was seen by Gruithuisen a tiny clear white crater. This tiny crater is in existence still, and is placed on the flat top of a very low ruined circular wall. But neither Klein or Schmidt have ever seen it as a white spot. It must, therefore, have grown darker in the course of years, and possibly in consequence of a comparatively recent eruption.

5. Another lies in the inside of the great walled plain *Alphonsus.* In the neighbourhood of the slope of the east wall is a dark triangular patch, which stands out very distinctly at full moon. In the midst of this patch Klein has discovered a crater-cone, which has hitherto been observed by no one else. Around this cone he observed a number of minute white points which he supposes to be the tops of low hills emerging from the surface of lava which has covered all the lower levels. The description he gives of this appearance is very like that of Miss Ashley in respect of the patches near *Theophilus.*

In all these cases Dr. Klein believes that the dark patch is formed of material ejected from the bright crater-cone; he also believes that this material becomes bleached with time, and then assumes that appearance which we see in so many "light-surrounded" craters.

These observations of Dr. Klein will doubtless encourage other observers to look for crater-cones on the numerous dark patches of an appearance similar to those mentioned above. The theory of the gradual bleaching of the lunar lava may perhaps be tested in some degree by a comparison of modern sketches with older ones; at any rate it shows how valuable careful sketches or light estimates of the lunar objects may become in time, especially if they are properly dated.

St. Mary's, Bayswater:
Oct. 23, 1882.

ASTRONOMICAL OCCURRENCES FOR NOVEMBER, 1882.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Saturn.
Wed	1		Sidereal Time at Mean Noon 14h. 42m. 41·08s.	1st Ec. D. 1st Oc. R.	15 4 30 18 19	12 43·2
Thur	2	6 57 13 34 14 30	☾ Moon's Last Quarter Occultation of κ Cancri (5) Reappearance of ditto	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	12 23 13 24 14 38 15 39	12 38·9
Fri	3		Sun's Meridian Passage 16m. 19·52s. before Mean Noon	1st Ec. D. 1st Oc. R. 1st Sh. I.	9 32 54 12 46 17 39	12 34·7
Sat	4			1st Sh. E. 1st Tr. E. 3rd Sh. I. 3rd Sh. E. 3rd Tr. I. 3rd Sh. E.	9 6 10 5 11 21 13 53 15 18 17 53	12 30·4
Sun	5			2nd Ec. D. 2nd Oc. R.	12 49 17 27	12 26·2
Mon	6					12 21·9
Tues	7			2nd Tr. E. 2nd Sh. E. 2nd Tr. E.	8 50 9 40 11 34	12 17·7
Wed	8	22	Conjunction of Moon and Mercury 4° 27′ N.	3rd Oc. R. 1st Ec. D.	7 29 16 58 15	12 13·4
Thur	9	17	Neptune at opposition to the Sun	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	14 17 15 10 16 32 17 25	12 9·2
Fri	10	11 19	● New Moon Eclipse of the Sun invisible at Greenwich	1st Ec. D. 1st Oc. R.	11 26 40 14 32	12 4·9
Sat	11	4	Conjunction of Moon and Mars 0° 56′ S.	1st Sh. E. 1st Tr. I. 1st Sh. E. 1st Tr. E. 3rd Sh. I. 3rd Sh. E.	8 45 9 37 11 0 11 52 15 20 17 53	12 0·6
Sun	12			1st Oc. R. 2nd Ec. D.	8 59 15 24 46	11 56·4
Mon	13	2	Conjunction of Moon and Venus 7° 17′ S.	1st Tr. E.	6 18	11 52·1
Tues	14	15	Saturn at opposition to the Sun	2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	9 32 11 9 12 15 13 52	11 47·9
Wed	15	4 37 5 31	Occultation of B.A.C. 6658 (6) Reappearance of ditto Illuminated portion of disc of Venus=0·127 Illuminated portion of disc of Mars=0·999	3rd Ec. R. 3rd Oc. D. 3rd Oc. R.	7 39 26 8 21 10 55	11 43·6
Thur	16		Sidereal Time at Mean Noon 15h. 41m. 49·40s.	2nd Oc. R. 2nd Sh I. 2nd Tr. I. 2nd Sh. E.	8 56 16 11 16 56 18 26	11 39·4

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Fri	17	20 41	☽ Moon's First Quarter	1st Ec. D. 1st Oc. R.	13 20 33 16 18	Saturn. 11 35·1
Sat	18		Sun's Meridian Passage 14m. 39.21s. before Mean Noon	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	10 39 11 22 12 54 13 37	11 30·8
Sun	19			1st Ec. D. 1st Oc. R. 2nd Ec. D.	7 49 6 10 44 18 0 28	11 26·6
Mon	20		Saturn's Ring: Major axis=46″·01 Minor axis=17″·85	1st Sh. E. 1st Tr. E.	7 23 8 4	11 22·3
Tues	21			2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	12 7 13 26 14 51 16 10	11 18·1
Wed	22			3rd Ec. D. 3rd Ec. R. 3rd Oc. D. 3rd Oc. R.	9 14 5 11 39 40 11 43 14 18	11 13·8
Thur	23	21	Conjunction of Moon and Saturn 2° 18′ S.	2nd Ec. D. 2nd Oc. R. 2nd Sh. I.	7 18 5 11 13 18 5	11 9·6
Fri	24	14 2 13 51 14 30	○ Full Moon Occultation of ω^1 Tauri (6) Reappearance of ditto	1st Ec. D. 1st Oc. R.	15 14 35 18 3	11 5·3
Sat	25	11 48 18 54 19 46	Near approach of B.A.C. 1563 (5½) Occultation of B.A.C. 1651 (6½) Reappearance of ditto	1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	12 33 13 7 14 48 15 22	11 1·1
Sun	26	10 29 11 38 16 54 17 52 12	Occultation of χ^2 Orionis (6) Reappearance of ditto Occultation of 71 Orionis (5½) Reappearance of ditto Conjunction of Moon and Jupiter 2° 52′ N.	1st Ec. D. 1st Oc. R.	9 43 10 12 29	10 56·8
Mon	27			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	7 2 7 33 9 17 9 48	10 52·6
Tues	28			1st Oc. R. 2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E.	6 55 14 43 15 42 17 27 18 25	10 48·3
Wed	29	11 41 12 50 17 59	Occultation of A^2 Cancri (6) Reappearance of ditto Near approach of 60 Cancri (6)	3rd Ec. D. 3rd Oc. R.	13 13 0 17 35	10 44·1
Thur	30			2nd Ec. D. 2nd Oc. R.	9 53 43 13 28	10 39·9
DEC. Fri	1			1st Ec. D.	17 8 45	10 35·6

THE PLANETS FOR NOVEMBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury...	1st	13 31 2	S. 7 16½	8″·0	22 41·2
	9th	13 52 9	S. 9 7	6″·2	22 34·2
	17th	14 34 0	S. 13 19½	5″·4	22 44·5
	25th	15 22 0	S. 17 39½	5″·0	23 0·9
Venus ...	1st	17 7 24	S. 28 0	40″·6	2 24·3
	9th	17 20 51	S. 27 59½	46″·4	2 6·3
	17th	17 24 39	S. 27 20	52″·8	1 38·6
	25th	17 17 15	S. 25 56	58″·8	0 59·8
Jupiter ...	1st	6 4 53	N. 23 0½	41″·6	15 19·7
	9th	6 2 54	N. 23 1	42″·6	14 46·2
	17th	6 0 4	N. 23 2	43″·2	14 12·0
	25th	5 56 31	N. 23 2½	43″·8	13 37·0
Saturn ...	1st	3 27 56	N. 16 22½	18″·2	12 43·2
	9th	3 25 23	N. 16 13	18″·2	12 9·2
	17th	3 22 46	N. 16 3½	18″·2	11 35·1
	25th	3 20 11	N. 15 54½	18″·2	11 1·1
Neptune...	1st	3 2 50	N. 15 21	...	12 18·1
	17th	3 1 3	N. 15 14	...	11 13·4

Mercury rises about an hour and three quarters before the sun, at the beginning of the month, the interval slightly increasing; on the 17th at an hour and thirty-seven minutes before the sun, the interval decreasing.

Venus sets an hour and ten minutes after the sun on the 1st, the interval decreasing.

Jupiter rises about two hours and a half after sunset, at the beginning of the month, the interval decreasing.

Saturn rises about three-quarters of an hour after sunset, the interval decreasing.

THE COMET CRULS.

Notes on the behaviour of the nucleus of the comet known as that of *Cruls*, translated from various numbers of the *Astronomische Nachrichten*.

From the *A. N.*, No. 2461.

Observation of the comet of Cruls at Louvain on the 2nd of October, 1882.

On the 2nd of October, from 17h. to 17h. 30m., I have observed the comet of Cruls, the condition of the sky not being favourable. I found the comet by the aid of a good binocular. The nucleus looked like a star of the first magnitude, and the tail, although very visible, did not extend beyond a distance of 1° or thereabouts, owing to the thin vapours with which the faulty vista of which I could avail myself was loaded. These vapours were sufficiently thick to render the object subsequently invisible

in the finder of my refractor by Segretan. With a power of 38 I could see only the nucleus and the coma, but, what was extraordinary, although the instrument was well in focus, the nucleus appeared to be double; there seemed to be a supplementary nucleus on the side opposite to the sun, and was perhaps attributable to a greater brilliance of the tail in this region. At any rate, I am confident that at that part of the sky where the comet was, there is no star of sufficient brilliance to bring this appearance about by being in the neighbourhood of the nucleus.

Dr. F. TERBY.

From the *A. N.*, No. 2462.

Letter of the Director of the Observatory at Palermo.

The nucleus of the comet (of Cruls ?) which at the period of our earliest observation (21—22) was almost spherical in shape, altered subsequently sensibly therefrom, becoming oblong, with a slight curvature, forming a compact whole, the light thereof being extremely brilliant, differing from what it was when originally observed. On the successive mornings the nucleus increased in brilliance, almost like a first magnitude star. The elongation continued to be seen, but separated from the nucleus by a narrow dark interval; at the same time the boundary of the elongation put forth a considerable increase of brilliance. Are we to look upon this kind of elongation as an appendage of the nucleus, brought about by the proximity of the sun, or that, as was the case with Biela's comet, we have before us two nuclei, the emanations from which remain separated by dark intervals? Ideas such as these may arise in the like circumstances, and may gather weight from ulterior observations.

Palermo: Oct. 5, 1882. G. CACCIATORE, Director.

From the *A. N.*, No. 2462.

Elements of the Comet of Cruls.*

Messrs. S. C. Chandler and O. C. Wendell forward from Boston, in the United States, a calculation performed by them for the orbit of the comet of Cruls, whence the following elliptic elements are deduced:

Perihelion, 1882, Sept. 17—18, M.T.G.

Longitude of Perihelion	58°	31′	m. E. 1882.
„ Node	346	52	
Inclination	142	35	
Log. Perihelion distance	7·9445.		

The eccentricity of the orbit is 0·9981, and the period is 3155 days.

Berlin: 1882, Oct. 6. Dr. H. OPPENHEIM.

* According to information received from England the comet of Cruls was discovered as long ago as the 8th of Sept., by Mr. Finlay, First Assistant at the Cape Observatory.—KRÜGER.

From *A. N.*, No. 2462.

Remarks by Dr. A. Krueger.

Oct. 5.—Owing to the weather, it was to-day that we were first enabled to see and observe the comet. The tail, which is directed towards α Hydræ, was visible long before the comet rose. At certain moments of more complete stillness of the air, the head of the comet seemed to me to consist of

two nuclei, the smaller of which, in the direction of the tail, with a position angle of 190′, was at a distance of 17″ from the larger main nucleus ; the entire nucleus in its longitudinal axis had an extent of 27″. At 17h. 53m. M.T., the comet became invisible, owing to the increase of daylight.

Oct. 6.—To-day the air was much less steady. As before, the following brightest portion of the nucleus was observed.

Oct. 7.—The air hazy; Barnard's comet very faint. The nucleus of the comet of Cruls appeared again to be double, the preceding fainter one irregularly elongated. Position angle = 188°; Distance 13″.

Oct. 8.—The air not quite clear. Position angle of the longitudinal axis of the nucleus = 187°.

The observations were made with the filar micrometer, with a bright field. One rotation of the screw = 21″·33.

A. KRUEGER.

From *A. N.*, No. 2463.

Observation of the Comet of Cruls by G. Cacciatore.

The nucleus of the comet, which on the morning of the 5th of October presented an oblong form, having a tolerably bright point in the lower part and a less luminous one in the upper—both those two points being surrounded by a dense nebulosity, and separated by a dark interval—assumed this morning a more shortened form. The lucid points are less bright. The nucleus is enveloped in denser nebulosity.

Palermo : 1882, Oct. 7. G. CACCIATORE, Director.

From *A. N.*, No. 2463.

Position of Comet of Cruls on 3rd November, 1882, 12h. M. T. Berlin.

1882.	R. A.	Decl.
Nov. 3	9h. 51m. 34s.	S. 20° 35′·4

KARL ZELBR.

DUN ECHT CIRCULAR, No. 60.

The great comet was found here at 16h. 53m., local time, on Sept. 29th, almost exactly in the place given by the elements deduced by Mr. Chandler (see Circular 59).

The nucleus was still as bright as a star of the first magnitude, hence the comet promises to be visible for a considerable time; I have therefore computed the following extension of the ephemeris.

Ephemeris for Greenwich Midnight.

1882.	α h. m. s.	δ ° ′	Δ	r
Oct. 2	10 41 2	− 7 28	1·34	0·67
3	10 39 31	7 55		
4	10 38 4	8 21		
5	10 36 42	8 47		
6	10 35 22	9 12	1·39	0·78
7	10 34 4	9 37		
8	10 32 49	10 2		
9	10 31 36	10 26		

1882.	h. m. s.	° ′		
Oct. 10	10 30 25	10 50	1·42	0·89
11	10 29 16	11 14		
12	10 28 8	11 38		
13	10 27 1	12 1		
14	10 25 55	12 24	1·45	0·99
15	10 24 49	12 46		
16	10 23 43	13 9		
17	10 22 37	13 31		
18	10 21 31	—13 54	1·47	1·08

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, September 30.

DUN ECHT CIRCULAR, No. 61.

Professor Weiss, of Vienna, has obligingly telegraphed by the *Science Observer* Code the following improved elements and ephemeris of the great comet, which he has deduced from observations on September 18, 23, and 25.

Elements.

T = 1882, September 17·42 Greenwich Mean Time.
π-☊ = 87° 58′ }
☊ = 350 44 } Mean Equinox, 1882·0.
i = 143 42 }
log. q = 8·52634

Ephemeris for Berlin midnight.

1882	α	δ	Brightness.
	h. m. s.	° ′	
Oct. 1	10 39 12	— 7 21	0·03
5	10 30 48	9 23	
9	10 23 16	11 20	
13	10 16 8	—13 13	0·01

Professor Weiss considers the comet to be identical with that of 1668.

Lord Crawford's Observatory, RALPH COPELAND.
Dun Echt: 1882, October 3.

DUN ECHT CIRCULAR, No. 62.

Messrs. S. C. Chandler, jun., and O. C. Wendell, of Harvard College, Cambridge, U.S., telegraph the subjoined remarkable elements of the great comet (Cruls).

Elements.

T = 1882, September 17·18, Greenwich M.T.
π-☊ = 71° 40′ }
☊ = 346 52 } Mean Equinox 1882·0
i = 142 35 }
log. q = 7·94448
Eccentricity = 0·9981
Period 3115 days.

On the other hand, Dr. Oppenheim still makes the orbit parabolic, with $\log q = 7{\cdot}88036$.

Lord Crawford's Observatory, Dun Echt: 1882, October 6. RALPH COPELAND.

DUN ECHT CIRCULAR, No. 63.

Elements and Ephemeris of the great comet of 1882.

The elements are computed from observations at Dun Echt Sept. 17 (18), Coimbra Sept. 19 (20), and Vienna Sept. 28.

Elements.

$$\left.\begin{array}{rcl} T & = & 1882,\ \text{September } 17{\cdot}2686 \text{ Berlin M. T.} \\ \pi\text{-}\Omega & = & 69^\circ\ 5'\ 36'' \\ \Omega & = & 345\ \ 43\ \ 24 \\ i & = & 141\ \ 47\ \ 58 \\ \log q & = & 7{\cdot}88036 \end{array}\right.$$

($\pi\text{-}\Omega$, Ω, i: Mean Equinox 1882·0)

The representation of the middle observation is:

$$\Delta\beta = +24'' ; \qquad \Delta\beta = +3''.$$

Ephemeris for Berlin Midnight.

1882.	α h. m. s.	δ ° ′	log. Δ	log. r
Oct. 11	10 24 42	—11 45·7	0·1464	9·9608
12	10 23 21	12 10·7		
13	10 22 1	12 35·5		
14	10 20 42	13 0·0		
15	10 19 24	13 24·2	0·1540	0·0055
16	10 18 5	13 48·3		
17	10 16 47	14 12·2		
18	10 15 29	14 36·0		
19	10 14 11	—14 59·8	0·1596	0·0439

Berlin: 1882, October 2. Dr. H. OPPENHEIM.

Of the same comet Professor E. Millosevich kindly communicates the following observation:—

1882, October 1, 16h. 46m. 12s. Rome M. T.

$$\alpha' - \alpha = +\ 3\text{m. } 45{\cdot}41\text{s.}; \qquad \delta' - \delta = +\ 5'\ 36''{\cdot}5$$

Comparison star: Lamont, *Muenchen*, —3° —9° No. 952.
App. α comet = 10h. 39m. 44·47s. (9·637n.)
App. δ comet = —7° 20′ 57″·0 (0·779)

Lord Crawford's Observatory, Dun Echt: 1882, October 9. J. G. LOHSE.

DUN ECHT CIRCULAR, No. 64.

A telegram has been received from the Vienna Academy, a copy of which was also kindly forwarded by the Astronomer-Royal, announcing

that Professor Schmidt at Athens discovered on October 8th, a comet only 4° south-west of the great comet, and having the same motion.

Should further observations confirm the last statement, this new comet would seem to be a companion of the great comet, and may have formed part of it at a former, not necessarily very remote time, judging by the history of the celebrated comet Biela.

The following observation of the great comet Cruls was kindly communicated by Professor E. Millosevich:

1882, October 6, 17h. 2m. 1s. Rome M. T.
α Comet = 10h. 31m. 25·92s.
δ Comet = $-$ 9° 40′ 57″·3.

Lord Crawford's Observatory, J. G. LOHSE.
Dun Echt: 1882, October 13.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Oct., 1882.	To Dec., 1882.
Knobel, E. B.	Benson, Rev. C. W.
Pritchard, Rev. Prof.	Watson, J.
Stothard, Dr.	**To Dec., 1883.**
Thomas, J. H.	Common, A. S.
	Tidmarsh, Rev. J. B.

TO CORRESPONDENTS.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to John C. Jackson, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. Jackson. 11, *Angel Court, Throgmorton Street, E.C.*, **not later than the 20th of the Month.**

NOTICE.

It has been suggested to us that a General Index of our first Twenty Volumes would be both useful and agreeable to our Subscribers. Such an index could be supplied to Subscribers for 3s. 6d. per copy, in advance, provided a sufficient number of copies were ordered. If this suggestion meets with the necessary support of our Subscribers, we shall be glad to put the matter in hand. **An immediate application is requested.**

The Astronomical Register.

No. 240. DECEMBER. 1882.

ROYAL ASTRONOMICAL SOCIETY.

Session 1882—83.

First Meeting after the Long Vacation, November 10th, 1882.

E. J. Stone, Esq., *President*, in the Chair.

Secretaries—J. W. L. Glaisher, Esq., and E. B. Knobel, Esq.

The minutes of the preceding meeting were read and confirmed.

Mr. Knobel announced that 153 presents had been received since the last meeting of the Society.

The following gentlemen were duly elected Associates of the Society:

Prof. H. G. van de Sande Bakhuyzen, Observatory, Leiden.
Dr. W. Döllen, Observatory, Pulkowa.
Dr. W. Klinkerfues, Observatory, Göttingen.
Dr. H. Schultz, Observatory, Upsala.
Prof. H. C. Vogel, Observatory, Potsdam.

The following gentlemen were elected Fellows of the Society:

R. Bryant, Esq., 11, King Street, Tower Hill, E.C.
Capt. A. Lister Kaye, Manor House, Stretton-on-Dunsmore, Rugby.
J. McCarthy, Esq., Cheltenham.

Prof. Pritchard read a paper, entitled *On certain deviations from the law of apertures in relation to stellar photometry, and on the applicability of a glass wedge to the determination of the magnitudes of coloured stars.* He said: I have been for some time engaged in the photometric examination of the relative brightness of the stars by means of an instrument which, though not new in its

several component parts, claims to be entirely new in their combination and mode of application. The first section of the work is now all but completed, viz.: that which includes the relative brightness of all stars from the pole to the equator which, in the catalogue of Heis, are estimated as brighter than the full 5th order of brightness, together with a few other stars. In the course of this research some facts of considerable importance have presented themselves. At the early stage of the inquiry a doubt arose as to the perfect accuracy of the law which expresses the ratio of the amount of light transmitted on varying the aperture of the object-glass. In my method of stellar photometry, the accuracy of this law was assumed as exact, and formed a material element in the reduction of the observations. I had determined, from several hundred measures, that a certain thickness of neutral-tinted glass, indicated by measured intervals along a wedge, reduced the light of the star by the same amount as that which is extinguished by half an aperture of the object glass. The amount of the thickness of the neutral-tinted wedge, which extinguished as much light as is extinguished by half an aperture was only $\frac{1}{80}$ of an inch in thickness, from which you may judge of the delicacy of the instrument. I was led to doubt the accuracy of the law from the nature of certain resulting deductions, and from a consideration of the complex structure of the object-glass, consisting virtually of a series of reversed wedges of two different kinds of glass and of different thicknesses. I was somewhat startled also by the conclusions arrived at by Dr. Wolf, of Bonn, in his photometric observations at Leipsic, in 1877. Dr. Wolf states that he used the wedge photometer after having submitted it to the necessary tests, and among these he measured the amount of light transmitted by apertures which were in the ratio of 2, 3, and 1; the ratio of light he expected would have been 9, 4, and 1, but the ratios came out utterly discordant as it seemed to him. I was quite sure that in the case of my own inquiries, no such deviation from the generally received law of apertures could possibly exist; but it was now more than ever necessary for me to determine the exact ratio of the light transmitted by varying apertures. The late Mr. Johnson undertook a series of experiments in the same direction, and found that one of the halves of the heliometer objective transmitted more light than the other in the relation of 1,000 to 924. Probably, the central parts of the Oxford objective are more transparent than the parts near the circumference. It was, therefore, necessary for me for the purpose of establishing the exactness of my own photometer to make some crucial experiments. The first process was to ascertain, by means of my wedges, the relative amount of

light transmitted, first by the full aperture of 4 inches, and secondly by the reduced aperture of 2 inches, and thirdly by the full aperture having a circular patch of 2 inches in the centre. But instead of having recourse to this process, which would require time and many observations, I thought it better to make an independent photometric examination, founded on the same principle of double refraction as has been so successfully applied by Professor Pickering, at Harvard College, a process of great beauty and accuracy. It consists of comparing the amount of light transmitted at different points of a wedge by means of a double image prism of quartz and a Nicol prism. The wedge was examined at every $\frac{1}{10}$th of an inch throughout its extent; and its general uniformity was established to a degree which I had hardly ventured to expect. The conclusion I arrived at was, that on the hypothesis of the practical uniformity of the wedge, the measures of light would not lead to any error exceeding about $\frac{1}{13}$th of a magnitude. Then follows in the paper a table in which the measures are exhibited, from which it appears that the wedge is practically uniform. The discussion of the results leads also to the ratio of the light transmitted by the two telescopes employed when the apertures are halved, and that was, in fact, my main object in devising this form of photometer. This ratio in the case of the four-inch telescopes was 3,918 to 1, and in the other three-inch telescope 3,921 to 1. These approximate to the ratio of 4 to 1 hitherto adopted, but, nevertheless, the error thus introduced in the photometric reduction would be by no means inconsiderable. This deviation from exactness was sufficient to compel me to modify the reductions of the observations of several hundred stars. Further, these investigations seem to suggest that it would be impossible to apply any method of telescopic apertures alone (I am speaking of refractors) to the photometry of the stars unless the idiosyncracies of the particular object-glass employed were accurately ascertained by some independent method of photometry. While engaged in the foregoing inquiry into the capacity of the wedge, as regards the uniformity of its absorption of ordinary lights, I availed myself of the opportunity of examining its effect on lights of different colours, and how far the wedge method of photometry could be relied on in the case of coloured stars, single or double. With this view I interposed coloured glasses and other coloured media between the sources of light and the wedge; and I ascertained as the result that, within the limits of our unavoidable errors, the absorption of the same thickness of wedge practically absorbed the same amount of light, whether its colour be red, orange, yellow, green, or blue, etc. I was greatly surprised at this result, though, in part, it might have been

anticipated. If this result be confirmed by still more numerous observations, it is obvious that in the wedge we possess an instrument applicable to the photometry of coloured stars. In further confirmation of this, I place a few observations of coloured double stars made at Oxford with the wedge now referred to, in juxtaposition with some observations made by Professor Pickering with the double image photometer. The results of the two methods accord to a surprising degree. Professor Pickering's photometer is antithetical to ours, but the Oxford photometry agrees with the American photometry on the average within $\frac{1}{10}$th of a magnitude, which is very difficult to measure; but both differ from Struve by more than $\frac{3}{10}$ths. This is decidedly encouraging to pursue the matter further. I do not know whether I am right or whether Professor Pickering is right, but I think the wedge method would probably be found to agree better with the facts than the double-image method. Another question remains for consideration, and that is, the effect of the atmosphere on the light of stars seen at different altitudes. At altitudes exceeding 50 degrees, the difference in the amount of atmospheric extinction of light is too small to be allowed for; between 50 and 60 degrees the difference is one that cannot be measured; but at lower altitudes the effects are so variable that sensible errors might easily be admitted from that cause. Considering the importance of the meteorological and geographical conditions under which these observations should be made, I have projected a journey to the south, probably to Cairo, to collect additional information for the solution of this problem, so as to render this contribution to stellar photometry as complete as possible. (Hear, hear.) The experiments I have already made have shown, first, the caution necessary in adapting the method of photometry to varying telescopic apertures; secondly, the possibility of securing the practical accuracy of stellar photometry by the use of a wedge of neutral-tinted glass; and thirdly, the possibility of correctly measuring thereby the relative brilliancy of coloured stars, whether single or double. In these respects, I hope, something useful has been added to our astronomical methods of research.

Mr. Knobel: I apprehend that the statement of Professor Pritchard, that the generally received law of the ratio between the light of an object and the aperture at which it is extinguished does not hold good in a refractor is quite akin to the well-known fact that a large object-glass, reduced to the diameter of a small object-glass, is a more powerful instrument in its definition. I cannot imagine there can be any difference in principle involved in those two points. One can say little about the paper until it

is in print, we can then study the figures; but the point mentioned with regard to the extinguishing of a star, no matter what its colour, by a similar thickness of the wedge is an extremely valuable and novel feature (hear, hear,) which will render photometry a much easier matter by the method of the wedge extinguishment than by that of limiting apertures.

Mr. De La Rue: I would like to ask one question of Professor Pritchard, knowing that he has at his disposal the means of making the requisite experiments—namely, whether he has tested the law of the diminishing of the aperture with the reflector as well as with the refractor?

The Astronomer Royal: I would also like to ask whether Professor Pritchard can discriminate by his experiments between the effect of diffraction with different apertures and the effect of the difference in the aberration and absorption of the object-glass?

Mr. Howlett: I would like to ask whether we are any longer to consider that the yellow rays of the spectrum are the most vivid if the wedge exerts the same influence in extinguishing stars of all colours?

Professor Pritchard: Mr. De La Rue has put a pertinent question, but "sufficient unto the day is the evil thereof." I found the work so laborious that I did not go into the extreme labour that would be entailed by taking the reflector as well as the refractor, but when I have finished this work I should like to try it. I cannot see why any difference should be expected unless we should find that a part of even Mr. De La Rue's mirror is not so well polished as the rest, which may probably be the reason why Mr. Johnson found one of the halves of the heliometer more translucent than the other. If Mr. Knobel were not present I would speak in higher terms of what he has done than I can venture to do in his presence; but if he had proceeded with his work, I think he would have anticipated me in presenting to the Society a catalogue of the magnitudes of stars which would, I think, be at least as valuable as the one I hope soon to give to the Society. As to the next question, I would ask—are we to suppose that there is a contradiction in what I have said as to the absorptive power of this neutral-tinted wedge, and that the absorbing power varies with the intensity of the different lights. The yellow light is very much more intense than the blue, and so on. No doubt of it. What I say is, that the ratio of the light absorbed is the same whether the light is blue, red, or any other colour. They are equally absorbed; that is all I say.

The President: Is the ratio of absorption you have mentioned the ratio over a large portion of the wedge, or only for small consecutive portions?

Professor Pritchard: We take the wedge from one end to the other. Observations were made at every 1-10th of an inch. We compared the apertures from one end to the other. The ratio of the light, coming through two small rectilinear apertures, at certain intervals of one-third of an inch, was the same for the different intervals.

The President: The relative ratio of these two small areas close together?

Professor Pritchard: No; one-third of an inch off. We selected that to represent the effect of half an aperture; but it is impossible to judge accurately of what we are speaking about unless you read the Paper in which the figures show how it is done. It is almost impossible that we could have been led into any error. The experiments were carefully done; and we think they must be right, because Professor Pickering has come to almost the some conclusion with his photometer, which is quite antithetical to ours. The Astronomer Royal put a question which I should be glad if he would repeat.

The Astronomer Royal: My question was, whether you had taken account in your experiments of the different size of the diffraction image in the case of a large aperture and a small one, and how that would bear on this question of the difference between the theoretical and observed ratios that you have got?

Professor Pritchard: In the use of this photometer you must be careful to avoid a large diffraction image. It would lead to a great deal of trouble if you got largely diffused discs. Therefore I know nothing about that. The only thing is we halved our aperture, and went on with our work (laughter). I suppose the results must be correct, because one cannot see any reason for incorrectness, and the results agree with the measures made many thousands of miles away by Professor Pickering. With the help of all these observations I think we shall get a catalogue of stars, of which the magnitudes are, upon the whole, correct to within 1-10th of a magnitude, and I think that will be a step in advance.

Mr. Brett: Is it not true that diffraction has a great deal to do with the visibility of stars? because without diffraction the size of the star's image would be so small that it would fall between the rods and cones of the retina, and no star would be seen at all, whereas the greater the diffraction image the more visible the little stars will be.

The thanks of the Society were voted to Professor Pritchard for his paper.

Mr. Knobel read a Paper from Mr. David Gill, describing a series of heliometer and other observations of comets I. and II.

1881, and some meridian observations of the great comet 1882, supplemented by notes by Mr. D. Gill on the great comet of 1882, first seen on the 8th September.

Mr. Gill described how he saw the comet on returning home from his observatory. He directed observations to be made with the great Indian Theodolite of 3½ inches aperture. The following morning two glimpses were obtained, and a long series of altazimuth observations were made. The next day the observations established the brilliancy of the comet. The light of the comet seemed in no way dimmed by the sun's rays. It was only necessary to darken the sun by the hand, and the comet showed with a sharply defined bright tail half a degree in length. He secured complete meridian observations on Sept. 18 and Sept. 22. On the 17th and 18th the comet was as easily discerned as a star of the first magnitude seen in daylight. The change of form in the nucleus, as observed from day to day, was extremely interesting. An accompanying report by Mr. Finlay described several observations of the comet. On Sunday, September 17th, the comet was visible all day. Observed with the 6-in. equatorial, and a power of 110, and neutral tinted wedge. At 4.40, with the sun's edge visible at the end of the field, the silvery light of the comet presented a remarkable contrast with the edge of the sun. After some minutes the increasing rate at which the comet was closing up to the limb rendered it certain it would reach the sun in a short time. He therefore kept the sun's limb at the edge of the field, and followed the comet right into the boiling of the limb, when he lost sight of it suddenly. When the sun's limb was boiling up he thought he caught a glimpse of it three seconds later. He then examined the sun's disc, but could not see the comet. The sun was then very low, and the definition bad. Two measures with the micrometer gave four seconds for the diameter of the comet's disc. Another accompanying report by Dr. Elkin recorded that on the 18th September the comet appeared about as bright as a star of the third or fourth magnitude, with a tail 2½ or 3 degrees in length. The breadth of the coma at the nucleus was estimated at 40 to 50 seconds. The southern edge of the tail was sharply defined, but the northern one faded away 12 or 15 seconds from the edge. The comet's light appeared simply white. With a low power of sixty, and screening down the light of the sun with wire gauze screens, the amount of false light rather impeded the visibility of the comet; but it soon became apparent that it could be followed close up to the sun; and it disappeared in the undulations of the limb at 4h. 50m. 52s., Cape mean time. The observation was made as accurately as the occultation of a star of the fourth magnitude at

the limb of the full moon, the intense brilliancy of the nucleus and a small portion of the emanations from it were scarcely inferior to the sun's surface itself. It was not possible to see whether the comet was passing behind the sun or between us and the sun; but as the latter proved to have been the case, the comet's invisibility on the sun's disc would lend additional interest to the observations.

Mr. Knott: Do these observations of Mr. Finlay accord with Mr. Hind's orbit made from observations after perihelion?

The President: There is another paper by Mr. Finlay and Dr. Elkin giving the orbit. Their calculations make the distance of the comet from the sun's limb at disappearance about five seconds of arc. The agreement is closer than could have been expected.

Mr. Penrose said he had been unable to get observations previous to perihelion except those that Mr. Gill had telegraphed. He might say that Crull's observation was totally discordant with any possible orbit. He had endeavoured to work out the orbit of this comet graphically; and though he had not succeeded fully, the results were respectable, and were entirely independent of any published elements. Mr. Penrose proceeded to describe his method; and observed that it seemed to come out from his work, that there was at the passage of perihelion, or a short time afterwards, a swinging round of the node through more than two degrees.

Mr. Ranyard: In regard to the few observations of the transit of comets across the sun or the corona, it must not be assumed that because this comet was not seen on the sun's disc while it was passing between the earth and the sun, that no other comet could be seen under similar circumstances. There is the well-known observation of Pastorff, in which he drew a nebulous object with a bright nucleus upon the disc of the sun, which was supposed to be the comet of 1819 seen in transit. There are facts which throw doubt upon this observation; but the fact that this comet was not seen in transit must not be taken as conclusive evidence that Pastorff could not have seen such a body. The relative brightness of the comet to the sun would no doubt depend upon the comet's distance from the sun. We have had an instance of a comet which was seen as a dark object projected upon the corona in 1871, and another comet which was seen as a bright object beside the corona in 1882. We cannot suppose that this comet was as hot as the sun, and yet here is an instance of a mass of comparatively cool gas between us and the sun which did not sensibly absorb the light from the hotter background. No doubt the law which regulates the amount of absorption of light in passing through a gas must depend upon the relative

temperature of the gas to the background. Here we have the case of a gaseous body, undoubtedly not as hot* as the sun itself, and not visible as a dark body on the sun. The law of absorption as ordinarily stated has given way, and is evidently not accurately true.

The President: Mr. Brett has a drawing of the comet to exhibit and explain.

Mr. Brett: We have heard a great deal of the artist's criticism of the astronomer's drawings. I should like to hear the criticism of astronomers upon an artist's drawing, and see whether we can come to anything like a fair agreement on these points. (Laughter.) All the members of the society nearly are amateur draughtsmen, and the normal attitude of the mind of the amateur draughtsman is, that his work has no artistic merit, but is correct. I feel that the opposite is the condition of the professional mind. (Laughter.) As this drawing is the best I can do, it only remains for you to criticise it, and show where it is inaccurate. The peculiarity of this comet is, that it has a remarkable tail, whereas the great comet last year had a remarkable head; this is the only comet in which I have seen the termination of the tail; the tails of all the other comets I have seen, since 1858, have been entirely lost, or so diffused that they could not be traced. You can see the shape of this tail at the end; it is divided into 3 horns, the central horn being most conspicuous at the time of the drawing. They have now disappeared gradually. On the 23rd October, the principal bay between the horns was very distinct. The criticism I make myself on this drawing is, that the lower horn is not pronounced enough. It is an extremely difficult thing to draw a nebulous object. I have never seen a satisfactoy drawing of a comet; but Dr. Huggins has made a very respectable drawing of a comet, and, probably, Sig. Tempel will be able to produce something superior to mine, because he is a first-rate draughtsman. The peculiarity of the northern edge of the tail is, that it appears elliptical, and the peculiarity of the southern boundary is, that it is very intense. As regards the nucleus, with the 9-inch reflector, there was

* [Note by Mr. Ranyard]. Since the meeting it has occurred to me that the comet might have been heated by the resistance experienced in its passage through the corona. We are familiar with the fact that meteors are heated, in their passage through the earth's atmosphere, up to bright incandescence, and the comet may similarly have been heated to a temperature far above the temperature of the space in which it was moving. My remark as to the law of absorption still holds good. We see D_3 as a bright line, but never as a dark absorption line, although the matter which gives the D_3 line is no doubt cooler on the outside than at lower depths. And many of the nebulæ give bright lines although the gas of their exterior portions is no doubt cooler than the gaseous mass within, which cannot radiate freely into space.

evident combustion visible. I cannot say it was like sparks, but certainly it suggested sparks. The nucleus was not round, but of a pear shape. With the 4-inch equatorial I could only discover an oval patch in the nucleus. The 9-inch reflector shows a turmoil of light about the nucleus. The mornings were exceptionally clear and beautiful; the time of observation was between half-past 3 and 5 in the morning, and the zodiacal light was very conspicuous.

Mr. Knobel: I observed the comet the same morning as Mr. Brett made this drawing, and certainly in the bay he refers to, in that part of the tail there was an extraordinary brilliance; but the form is not exactly what I should have drawn. I should have said the whole body of the tail was broader relatively to its length. I could not see it so wide at the extremity of the tail, nor could I see that elliptical curve he has delineated, but I concur with what he said about the extreme brilliancy of the termination of the tail, especially in that bay at the end of it, though I did not see the triple character he has drawn. I ought to mention that the zodiacal light was very brilliant on that morning.

Mr. Common (being called on) said: It is easy enough to make remarks: the question is whether they are correct or not. (Laughter.) Mr. Brett has talked of the remarkable tail. I can speak of the remarkable head. When the comet was first seen in the telescope it appeared like that:—with a single nucleus, the sun being about 2 diameters away. As to the appearance of the head of the comet this month and last (October), it appeared to be in two parts, as it were. On the last day of October the nucleus was a slightly elliptical patch, brighter towards the middle, and the tail had no curve round like ordinary comets. On the morning of October 31st, it had altered into a double elongated nucleus, very much compressed and very much longer than before. It was about 100 seconds long and 10 seconds across. Next morning I was surprised to find a dark space in the nucleus which had still further elongated. In the photographs I have taken this shows distinctly. The presence of this dark space is most remarkable. I may mention, that in the next few mornings the comet will, I think, go between two little stars as through a gate, so that in the course of a few days, I may be able to get the two stars and the comet in a comparitively small field.

Mr. Ranyard: I should like to ask whether, when you were fortunate enough to see the comet close to the sun, the tail was radial with the sun's centre?

Mr. Common: Yes, exactly radial, and I especially observed that.

Mr. Ranyard : I can confirm what Mr. Common has said about the different brightness of the two sides of the comet's tail, the lower one seemed decidedly brighter morning after morning, so that there was a remarkable effect of want of symmetry.

The President announced that there were a considerable number of copies of the instructions for the observation of the Transit of Venus at the service of Fellows, and some few maps which had been enlarged from the American Almanack, giving times of ingress and egress at different parts of the earth. He might announce that all the expeditions from England were going on well. They had heard of the arrival of one party in Australia, and the expedition for Madagascar had already arrived at Natal, and exchanged signals to obtain time from Capetown. Mr. Marth's party had landed their instruments at the Cape after some trouble. There had been smallpox on board, and the Cape people wanted them to go on to Port Elizabeth, and send their instruments from that place, but had that been done the instruments might have been broken or might not have arrived in time. The only thing now to hope for was a fine day.*

The Astronomer Royal: I have received a circular from Dr. Förster, of Berlin, respecting a central office for the distribution of astronomical telegrams, to be established at Kiel, under Professor Krüger's direction. Subscriptions are invited; observatories all over the world are to contribute each £6 a year, half of which is to be devoted to office expenses, and the other half to the cost of distributing the telegrams, and also to pay for the telegrams that may be received. Dr. Förster says, that 25 observatories, in nearly all European countries, have declared their adhesion to the plan, and the leading astronomers in each country have agreed to act as a Committee. I understand that this will not interfere with the excellent work which Lord Crawford has undertaken in distributing telegrams from Dunecht, but that the new office will serve as a centre, to which telegrams from all countries may be sent and from which they will be distributed all over Europe. The Dunecht circulars will still keep their place, I hope, in this country, and give information to English astronomers. It is proposed to adopt some cipher code, probably that which has

* [Note by Mr. Stone.] The smallpox was at Cape Town, and ships landing cargo there could not proceed to Port Elizabeth without going into quarantine. This was, of course, feared by Donald Currie and Co., but the Colonial Secretary kindly forwarded, at my request, a telegram, asking the good offices of the Cape authorities to facilitate the landing of the instruments, and I telegraphed and secured a tug for the purpose of landing the instruments. All were thus safely landed.

proved so successful in sending the American messages of the *Science Observer.*

The following papers were also announced:—

J. Tebbutt: *Observations of comet* b, 1882, *made at Windsor, New South Wales.*

W. F. Denning: *The fireball radiants of August* 9-11.

W. S. Franks: *The electric light in observatories.*

W. F. Denning: *The markings on Jupiter.*

H. T. Vivian: *Elements of Comet III.* (*Schäberle*), 1881.

Rev. S. J. Johnson: *On a probable Assyrian transit of Venus.*

The Astronomer Royal: *Observations of comets* a, b, *and* c, 1882, *made at the Royal Observatory, Greenwich.*

Major A. B. Brown: *Solar eclipse of* 1882, *May* 17, *observed at Meerut, India.*

Captain G. Pochrane: *Sextant observations of the great comet of* 1882.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

No. 27 MONOCEROTIS.

Sir,—In searching for Barnard's comet recently, with the help of a binocular only, and Proctor's star maps, my attention has been accidentally drawn to the star 27 Monocerotis, which forms with 28 and 29 of the same constellation a nearly exact equilateral triangle, plainly visible to the naked eye. Of these three, 29 is the brightest, 28 is very nearly its equal, and 27 is the least bright. To my eye the difference between the last two is very slight, and the difference between the first two also slight; but the sum of these, which is the difference between 29 and 27, is unmistakable. I am not accustomed to estimating magnitudes, and could not therefore pretend to say more than the above, nor should I have occasion to say so much but for the fact that No. 27 does not appear at all on Proctor's map, while the other two appear as fifth magnitude stars. On turning to the authorities I

find that the magnitudes assigned by Argelander are: 6.5, 5.6, and 5, to Nos. 27, 28, 29 respectively. These agree well, relatively at least, with what I had myself noted before reference, as indicated above. In the B. A. C., on the other hand, the magnitudes are set down as $6\frac{1}{2}$, $5\frac{1}{2}$, $5\frac{1}{2}$. I was for some time puzzled by the absence of the 3rd star from the chart, having more clearly in view the close approach to equality of the 3 as actually seen, than the marked difference as indicated by the B. A. C. magnitudes. But on looking more carefully into the *Introduction* to those maps I perceived that the B. A. C. was the foundation on which they were constructed, and that the sixth magnitude was the limit adopted. This explains the non-appearance of the star in question in its place on the map, satisfactorily in one way, but less so in another. For it shows that *unless the star is variable*—in which case still more should it be in evidence—the foundation* is insufficient.

In any case, it is one of those which Mr. Proctor will doubtless take charge of, and in the meantime it may perhaps interest those who are on the look out for variables to ascertain the grounds on which the B. A. C. rates the star so much lower than Argelander and Bode.

Collingwood: October 25, 1882. J. HERSCHEL.

THE RED SPOT ON JUPITER.

Sir,—Mr. A. S. Williams (*Register*, Nov. p. 262) has not correctly rendered my statement in reference to the faintness of the red spot. He says, "It is by no means certain that its early *entire* disappearance may be *expected*," as I suggested. The words in italics were not used by me, and are certainly calculated to pervert my meaning. What I said was, that "the early disappearance of the spot was to be inferred from its rapidly increasing faintness." I am very far from thinking that the entire (*i.e.*, final or absolute) obliteration of the spot is at hand, though we must admit that if its recent decadence continues we shall lose it for a time. My strong belief is that this remarkable object is but a later phase of Gledhill–Mayer's ellipse of 1869—71, and the same object as that seen by Lord Rosse in 1873, and by Mr. Russell in 1876. It is a most significant fact in regard to this question of identity that the curiously bent belt immediately S. of the great S. belt, has been placed the same relatively to the

* Bode's Atlas, it seems, was constantly referred to in their construction. On reference, I find these three stars there depicted as 5th, 5th, 6th, respectively, the smallest being No. 29.

red spot during the last three years as it was in 1869—71. This belt, just N. of the following end of the red spot, abruptly slopes to the N., where it is connected with the edge of the great S. belt. The same curious feature was many times recorded by Gledhill, and we cannot but regard this as strong evidence as to the identity of his ellipse with Pritchett's red spot of more recent years.

Some of the chief markings on Jupiter are subject to great variations in distinctness. The white spot near the equator is sometimes wholly invisible, though occasionally it assumes a most brilliant appearance. These changes in the visibility of the markings are probably often due to obscuring vapours on the outermost envelope of the planet, and are not to be ascribed to physical changes in the objects themselves. A variable period of rotation, beyond such as errors of observation may originate, is a clear proof that a marking is of atmospheric character, and not a fixed portion of the planet, for we cannot admit that the actual sphere of Jupiter is subject to an erratic period of rotation. For this reason I cannot agree with those who consider the red spot to be a solid part of the Jovian surface. Its great "drift" in longitude, shown from recent observations, indicates that it is probably an object floating above the surface and wholly detached from it.

I pointed out (*Register*, Oct., p. 234—35) that between March 30 and Aug. 7 the movement of the spot corresponded with Mr. Marth's rotation period of 9h. 55m. 34·47s., and that therefore its motion had been slightly accelerated during that period. Since August I have obtained a number of observations which show that a great retardation of motion has subsequently occurred. Comparing the times of transit of the middle of the spot with those when the assumed first meridian of Jupiter passes the centre of the disc, I find the interval has been increasing rapidly as follows:

1882.		Red Spot Observed on C. M. h.	m.		Follows Marth's 1st Meridian. min.
Aug. 7	...	16	47	...	47·1
Sept. 15	...	14	6	...	57·5
29	...	15	31	...	52·8
Oct. 1	...	17	13	...	57·0
25	...	16	59	...	61·5
30	...	16	10	...	66·3
Nov. 1	...	17	54	...	72·7
4	...	15	22	...	71·2

Hence, during the last three months the spot has lost 25 min. relatively to the position of the assumed first meridian, whereas

during the four months preceding August it remained stationary with respect to it. These results show that in addition to the gradually increasing retardation of the spot there are irregular movements sustained over short intervals. Sometimes the motion is checked, at other periods it apparently receives undue impetus.

The remarkably slow motion of the red spot during the month of October has enabled the bright spot on the planet's equator to come to conjunction with it more than a day earlier than expected. I saw the bright spot at mid-transit on Oct. 30, at 16h. 22m., and on Nov. 1 at 17h. 40m. Comparing its position on these nights with that of the red spot, and remembering that the much swifter motion of the bright spot enables it to gain 13m. 24s. daily on the former object, we shall find that the epoch of conjunction was Oct. 31, 14h. 43m. Now, the last preceding conjunction occurred on Sept. 18, 7h., so that the complete revolution of the white spot was performed in 43d. 7h. 43m., whereas the average period is 44d. 10h. 42m. 13·3s. The next conjunction of these interesting objects will occur on Dec. 15, when the more favourable position of Jupiter will probably enlist more observers. If the planet is carefully observed at the following times the red spot will be seen nearly central, and the brilliant white spot indenting the equatorial margin of the great S. belt will be similarly placed:

1882.			h.	m.
Dec.	14	... ...	18	10
	15	... ..	14	0
	16	... ...	9	50

It will be important to determine the relative positions of the two spots at these times. This will be best effected by carefully noting the times of their transit across the central meridian.

Bristol: Nov. 5, 1882.

Yours faithfully,
W. F. DENNING.

P.S.—Nov. 25. Further observations of the red spot have been made here as follows:

1882.		Red Spot Observed on C.M. h.	m.		Follows Marth's 1st Meridian. min.
Nov. 6	...	16	58	...	70·7
8	...	18	33	...	68·2
17	...	10	59	...	68·8
20	...	18	26	...	71·9

W. F. D.

A PECULIAR KIND OF LUNAR LIGHT STREAK.

Sir,—It is a singular circumstance that the lunar light streaks, which form one of the most extensive class of objects visible on the moon's surface, have, up to the present time, nearly entirely escaped attention. Observers have spent the greater part of their lives in recording the numerous craters and mountains visible on the lunar surface, but have scarcely bestowed more than a passing glance upon this important class of objects. It is more unaccountable, because their features are probably better suited than any other to reveal *real* changes which may take place, and are also particularly well suited to afford evidence of the presence of an atmosphere. There are but very few formations which have been studied sufficiently well to give even the more prominent light markings, whilst those which have been subjected to what may be considered a fairly exhaustive examination, amount to only three or four. In all the last-mentioned cases, it may be remarked, considerable changes have been seen to take place, due perhaps in great measure to the presence of a lunar atmosphere, and it is certain that an observer who diligently studies these features, even with an instrument not exceeding two inches in aperture, may expect an abundant harvest of valuable results. It is not surprising, considering how these important features have been neglected, that at the present time a satisfactory explanation of the probable origin and nature of these streaks cannot be given.

For some time past I have been paying considerable attention to these nearly neglected objects, and have been struck with the existence of a class of streaks which I believe has hitherto not attracted much attention. The streaks of this class, to which the name of double streaks may be perhaps considered not altogether inapplicable, are of the following nature: A very common form of streak consists of a moderately bright, nearly uniform light band, often exceeding 100 miles in length, and on the edges merging almost imperceptibly into the surrounding surface. In some cases, however, when the observer has become thoroughly acquainted with the characteristics of the streak, one of these streaks, when examined carefully on a fine night, will be seen to be really double, two rather narrow streaks running side by side, and separated by an interval of considerably less than 1″ of arc. Moreover, the spots visible on one streak will frequently have similar spots situate exactly opposite them on the other streak, in such cases of course the appearance being that of a very close double spot, and its resemblance between the two objects is so

striking that it can scarcely be doubted some real connection must exist.

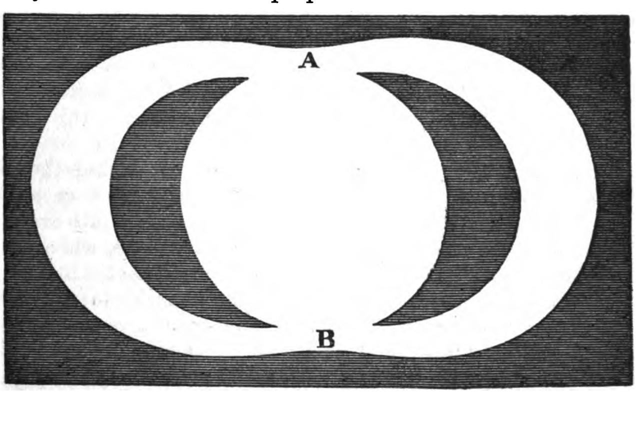
Up to the present time only a few of these somewhat curious objects have been detected, as until a streak is perfectly familiar it is not usually seen double, but the actual number is probably very great. Four are situate in Ptolemæus, two at least of which have spots on one streak exactly opposite similar spots on the other streak, one of which extends from near the crater-cone *n* to *m*. There is also one in the Mare Crisium, but of somewhat coarser character, as it was first divided with a $2\frac{3}{4}$-in. refractor and power of 102.

It is obvious that if there were a change in one, or both, of the components of one of these double streaks, so that sometimes one and sometimes the other was the brighter, an apparent change in the position of a streak might be accounted for, and such a variation has occurred in at least one of those in Ptolemæus.

West Brighton: Yours faithfully,
Nov. 8, 1882. A. STANLEY WILLIAMS.

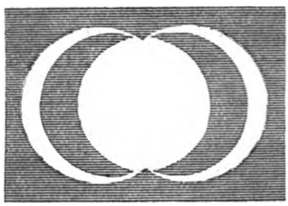
SATURN.

Sir,—In continuation of the inquiry initiated in your last number relative to the discovery of the primary division in Saturn's ring, it may perhaps interest your readers to have the following facsimile of Ball's engraving of the planet, which has been found wanting in so many copies of the first volume of the *Philosophical Transactions*. I have photographed it from the volume in the possession of G. J. Symons, Esq., F.R.S., who kindly lent it to me for the purpose.



This particular volume has a peculiar interest, as it must have belonged to its editor, Henry Oldenburge, and has his autograph on the cover. With respect to the difference which is found to exist between the delineation of this larger engraving and that given in Lowthorp's Abridgment, I quite agree with those who imagine that this difference may have arisen partly on account of the very reduced size of the latter, and partly from the carelessness or misapprehension of the engraver.

The following engraving of the planet, which is given by Hevelius in his "Selenographia," and which refers to an observation made by him about the year 1643, might perhaps have suggested, or justified, such a question as "Whether he there meets with nothing, that may make him think, that it is not *one* body of a circular figure that embraces his disc, but *two?*"



From the appearance of this engraving it would have required no very serious stretch of the imagination to have supposed that Saturn was indeed surrounded by two circular bodies apparently bisecting each other. Hevelius makes the following remarks respecting the above engraving: "Ejusmodi faciem Saturni in præsens diagramma consignavi. Hæc relatio de stellâ Saturni multis perquàm admirabilis et vix credibilis videtur; nec ego diffiteor, quòd initiò me ab assensu sustenuerim; postquam autem longiores ac meliores tubos mihi comparavi, et per eos Saturnum inspexi, hanc jam descriptam faciem Saturni non merum somnium esse, sed magnam partem ita cerni reapsè deprehendi."

Having established Cassini's right to be considered the discoverer of the primary division in Saturn's ring, it may not be amiss to point out that he has been credited with a discovery to which he has no claim whatever. A few days since, when reading Colonel Gold's translation of G. de Pontecoulant's history of Halley's comet, I met with the following remarkable statement on page 21: "The comet was also at the same time observed at Paris by Lahire, Picard, and above all by Dominick Cassini, for ever celebrated by his discovery of Jupiter's satellites." (?!)

As this translation was published so lately as 1835, it may be as well to point out this error, lest some future compiler of astronomical data may accidentally repeat the same. It was Galileo Galilei, as most of your readers are aware, who first saw the satellites of Jupiter on January 7th, 1610.

I beg to remain, Sir, your obedient servant,

The Observatory, Crowborough: C. LEESON PRINCE.
Nov. 15, 1882.

SATURN'S RING.

Sir,—Perhaps I may be permitted to put a question in connection with the very interesting letter by Mr. C. Leeson Prince, which appears in the *Astronomical Register* for the present month. I have already asked it in the columns of one of your most widely circulated scientific contemporaries, but without obtaining a direct reply: albeit it otherwise elicited information of very great interest and value. On p. 217 of Breen's "Planetary Worlds," published in 1854, I find its author saying, that "Shortly after this discovery" (*i.e.*, that by Huyghens that the globe of Saturn was surrounded by a thin flat ring) "a division in the ring was detected by the English observer Ball, and Huyghens was written to in 1665 by Wallis to direct his attention to the anses or ring, and to see 'whether he there meets with nothing that may make him think that it is not one body of circular figure that embraces his disc, but two.'"

What then I would inquire is this: Can any of my brother readers of the *Astronomical Register* inform me whether this letter—or an authentic copy of it—is still extant, and, if so, where can it be seen? I have somewhere read or heard that the correspondence of Huyghens was published about 50 years ago in Holland (I fancy at the Hague), but I do not know the title of the book. Wallis, as is well known, was Savilian Professor of Geometry at Oxford, and one of the original founders of what subsequently became the Royal Society, and it seems odd to me that a writer in the year 1854 should quote professedly verbatim from a letter of his, unless such letter was preserved in print. No impartial person reading Mr. Prince's excellent letter can doubt that the conclusion at which he has arrived is the only just and correct one; and it certainly seems to me important that we should, if possible, recover the *ipsissima verba* of a communication which appears to have formed the foundation of an error

that has universally prevailed for the last 60 years. If we assume that Breen spoke with authority, Wallis was pretty evidently the "person" referred to in Mr. Prince's quotation from the *Philosophical Transactions*, as Huyghens was undoubtedly "the worthy author of the system of this planet," and it would materially conduce to the solution of the origin of a strange mistake, if, as I have said, we could recover the very words in which the old Savilian Professor announced Ball's imaginary discovery to his immortal contemporary of Zulichem.

I am, Sir, obediently yours,
WILLIAM NOBLE.

Forest Lodge, Maresfield,
Uckfield: Nov. 11, 1882.

ECLIPSE OF THE SUN, May 6th, 1883.

Sir,—I went to Princeton yesterday to talk with Professor Young concerning an expedition to go to the South Pacific Ocean, to observe the great Eclipse of 6th May, 1883.

At the suggestion of Professor Young I write to you to ask if any movement has been made in this direction in England, and if your astronomers would be inclined to co-operate with us here in such an expedition.

I think Caroline Island is the only point from which the Eclipse can be well observed. Its position is given as 9° 54′ south latitude, 150°·06 west longitude (see "Findlay's South Pacific Directory," 742). The *centre* of the line of totality is given 10° 26′·7 south, 150° 16′·9 west.

In order to reach this island a steamer must be chartered in San Francisco especially for the trip, the cost of such a steamer for 2½ months would be about £2000.

I think the American party would be limited to six persons, perhaps eight, so that four or five gentlemen from England could be accommodated.

The duration of totality will be 5′ 42″ at the point 10° 26′S., 150° 17′W., and in view of the good results obtained in Egypt in May last, with a totality of only 1′ 12″, it seems worth while to consider this next opportunity.

Will you please bring this matter to the notice of some of your friends, and let me know your opinion as to the chances of enlisting recruits on your side of the water.

Very truly yours,
CHAS. H. ROCKWELL.

Tarrytown, New York:
Sept. 27, 1882.

REVIEWS.

The Wedge Photometer. By Edward C. Pickering. From the Proceedings of the American Academy of Arts and Sciences, May 10th, 1882.

"Much attention has recently been directed to the use of a wedge of shade glass as a means of measuring the light of the stars. While it has been maintained by various writers that this device is not a new one, the credit of its introduction as a practical method of stellar photometry seems clearly to belong to Professor Pritchard, Director of the University Observatory, Oxford. Various theoretical objections have been offered to this photometer, and numerous sources of error suggested. Professor Pritchard has made the best possible reply to these criticisms by measuring a number of stars, and showing that his results agreed very closely with those obtained elsewhere by wholly different methods. His instrument consists of a wedge of shade glass of a neutral tint, inserted in the field of view of the telescope, and moveable so that a star may be viewed through the thicker or thinner portions at will. The exact position is indicated by means of a scale. The light of different stars is measured by bringing them in turns to the centre of the field, and moving the wedge from the thin towards the thick end until the star disappears. The exact point of disappearance is then read by the scale. The stars must always be kept in the same part of the field, or the readings will not be comparable. By a long wedge the error from this source will be reduced. A second wedge in the reversed position will render the absorption uniform throughout the field. Instead of keeping the star in the same place by means of clock-work, the edges of the wedge may be placed parallel to the path of the star, when the effect of its motion will be insensible. To obtain the best results the work should be made purely differential, that is, frequent measures should be made of stars in the vicinity assumed as standards. Otherwise large errors may be committed, due to the varying sensitiveness of the eye, to the effect of moonlight, twilight, &c., and to various other causes."

"A still further simplification of this photometer may be effected by substituting the diurnal motion of the earth for the scale as a measure of the position of the star as regards the wedge. It is only necessary to insert in the field a bar parallel to the edge of the wedge, and place it at right angles to the diurnal motion, so that a star in its transit across the field will pass behind the bar and thus undergo a continually increasing absorption as it passes towards the thicker portion of the wedge. It will thus grow fainter and fainter until it finally disappears. It is now only necessary to measure the interval of time from the passage behind the bar until the star ceases to be visible, to determine the light. Moreover, all stars, whether bright or faint, will pass through the same phases, appearing in turn of the 10, 11, 12, &c., magnitude, until they finally become invisible." Professor Pickering gives the formulæ for the reduction of these observations, and shows how the single constant involved can be determined. He says, "The great advantage claimed for this form of wedge photometer is the simplicity of its construction, of the method of observing, and of the computations required to reduce the results. It may be easily transported and inserted in the field of any telescope, like a ring micrometer. The time, if the observer is alone, may be taken by a chronograph or stop-watch. Great accuracy is not needed, since if ten seconds correspond to one magnitude it will only be necessary to observe the time to single seconds." Various easy and useful applications of this instrument are suggested by the Professor, who

concludes by remarking that to an amateur who would regard the complexity of an instrument as a serious objection to it, a means is now afforded of easily reducing his estimates of magnitude to an absolute system, and thus rendering them of real value.

Variable Stars of Short Period. By Edward C. Pickering. Reprinted from the Proceedings of the American Academy of Arts and Sciences, Vol. XVI. Cambridge: University Press, John Wilson and Son. 1881.

In this paper Prof. Pickering extends his investigation (already noticed in the *Astronomical Register*) to stars whose changes of light are repeated with great regularity in a period not exceeding a few days, such as β Lyræ and δ Cephei. He regards these papers, however, as only preliminary discussions until a revision of the whole shall be made, when the constants involved are better known by the results of the observations now in progress at the Harvard College Observatory. From a list of 31 variable stars of short period he selects four which have been observed with great care: ζ Geminorum, β Lyræ, η Aquilæ, and δ Cephei, the constants used depending on the supposition that the variation of a star of short period is due to its revolution around its axis, and a deviation of the body from the form of a solid of revolution. From the investigation for ζ Geminorum, it would appear that this star is a surface of revolution, one side being about four-fifths of the brightness of the other. From table xii. it seems that "in every case the darker side is more than half as bright as the other, and that the difference in the case of β Lyræ amounts only to ten per cent. In other words, if this effect is due to spots, we must conclude that they cover only one-tenth of the hemisphere in the case of β Lyræ, and about two-fifths in the cases of η Aquila and δ Cephei. The next column also shows that β Lyræ is much elongated, the ratio of its axes being as five to three, while the two stars following have this ratio about as six to five." Prof. Pickering points out that interesting questions are connected with this investigation, and the study of the stars with the spectroscope and photometer, and he indicates some researches of importance that might be made. "The object of the present paper is not to advocate a certain theory, which may seem improbable, and, possibly to some, inadequate; it is rather intended to bring together the most important facts bearing on the study of an interesting class of objects, and to exhibit them in a form in which they may be subjected to any desired test. The hypothesis advanced has a value as affording a simple geometrical conception of the nature of the variations under consideration, even if it proves not to be the true explanation of the cause.

Prof. Pickering classifies the variables as follows: I. Temporary stars —examples, Tycho Brahe's star of 1572, new star in corona, 1866. II. Great variations in periods of several months or years—as *o* Ceti and χ Cygni. III. Slight changes, the laws of which are unknown—α Orionis and α Cassiopeia are examples. IV. Light continually varying with great regularity in a period not exceeding a few days—examples, β Lyræ and δ Cephei. V. Remarkable diminution of light for a few hours every few days, this phenomenon recurring with great regularity—examples, β Persei and S Cancri. He summarises the principal conclusions of his paper as follows: "Thirty-one variable stars are known whose period is less than 72 days. Of these six belong to the fifth class, or that of β Persei, in which the variation is probably due to the interposition of an opaque eclipsing satellite. Of the remainder seven may be excluded, since they are red, and may belong to the second class, or that of *o* Ceti. Nineteen

remain, whose periods vary from less than a day to 54 days, and which may be placed in the fourth class. All lie within 16° of a great circle, whose pole is in R.A. 13h., Dec. +20°. The distances of eleven are from 0° to 5°, of five at distances 8° and 9°, one at 14°, and one at 16°. The average distance is 5°·6, while if the stars were distributed at random it should be 30°. If the stars of the Durchmusterung [315,048 in number, north of the equator] were uniformly distributed, their average distance apart would be about 8′·7. The five stars of the fifth class have Durchmusterung companions at an average distance of 10′·6. In the fourth class, excluding the red stars, six are in the Durchmusterung, and have companions at an average distance of 2′·5, four being less than 2′·0 distance, one at 3′·2, and one at 6′·1 In all six cases the direction of the companions is within less than 34° of the plane near which the variables lie, or at an average distance of 18°, while if distributed by chance this angle should be 45°. Hence a method of discovering variable stars of this class is offered by looking in a certain part of the sky for those having near companions in a given direction. The light curves of four stars have been determined with sufficient precision to permit a comparison with theory. . . The difference between observation and theory amounts on the average to only about 0·03 of a magnitude. In other words, the light of these stars at any time may be computed with this degree of precision." The researches in this paper are of great interest. If the excellent photometric observations carried on at Harvard College Observatory are turned to account with the skill displayed by Prof. Pickering, and his suggestions are followed, important discoveries can hardly fail to result in more than one direction. The field is difficult to work, but it holds out good promise for the future.

LUNAR WORK FOR DECEMBER, 1882.

By the Rev. W. J. B. Richards, D.D., F.R.A.S.

Hyginus. The great interest felt at the present time in the neighbourhood of *Hyginus* makes it very desirable that the detail of the district should be mapped and catalogued as accurately and fully as possible. A list of objects is now given which have been already observed once, but of which it is now desired to obtain a second and confirmatory observation by another observer. I should be glad to receive a note of the confirmation of any of the objects in the following list, with a view to the completion of the District Catalogue. It would greatly add to the value of the observations if the positions of the objects were noted as exactly as possible, the distance being given in terms of the adopted unit, viz., $\frac{1}{124}$ of the moon's diameter. An idea of the magnitude of this unit may be easily gained by noticing the distance that a point on the lunar surface is carried away from a spider-line in the eyepiece by the earth's motion in a second of time. (See page 73.)

St. Mary's, Bayswater, W.:
Nov. 20, 1882.

Objects in the district of Hyginus requiring confirmation.

		P.	D.
1.	Dark spot N.E. of *a*	150	1·5
2.	Dark spot at W. end of *i*. Aligns with *c* and *p*, and is north of them. Compare note of Mr. Neison, *Sel. Jour.*, ii. p. 18	220	2·5

		P.	D.
3.	Three peaks (are either of them craters?) on κ. See note by Mr. Backhouse, *S. J.* iii. p. 35		
4.	Straight ridge or rill, north of the S.W. branch of Hyginus rill, parallel with this branch, from near *c* to *Hyginus*. See note by Gaudibert, *S. J.*, i. 25 and iv. 14		
5.	Streak, apparently a ridge, half-way across *z*. Compare Chart I. (rill ψ)		
6.	Two craters between west end of *i* and northern end of δ	350	2·5
7.	Large hill between *D* and northern end of δ, and some smaller ones near *D*	20	4·0
8.	A ridge from *b* to π		
9.	Two hills in *i*, at S.W. end	300	2·3
10.	Several objects in *i*, at E. end	340	2·5
11.	A crater north of the *Schneckenberg* (perhaps *g*)		
12.	Crater between δ and Hyginus rill. Compare Edgcumbe, *S. J.* ii. 20	30	1·5
13.	A crater (perhaps two) between west end of *i* and *z*	290	2·5
14.	Two or three spots like craters in a row with the last, reaching from west end of *i* to northern edge of *z*		
15.	Four or more hills on dark spot *o*, and perhaps two craters on its western edge	230	2·0
16.	Crater on southern edge of ξ	40	3·0
17.	A ring or perhaps a crater on northern end of δ	10	3·0
18.	Small crater on northern end of σ	320	1·5
19.	A rill close under σ, parallel with it on its eastern side		
20.	Perhaps a rill lying under κ, between it and *N*. (Are either this or the last Mr. Neison's? See *S. J.* iv. 28, and Klein, *S. J.* i. 9)		
21.	A rill branching from northern end of Hyginus rill and cutting through ξ quite to its eastern edge	40	3·5
22.	A rill between δ 1 and Hyginus rill, cutting the southern part of δ	30	1·5
23.	Perhaps a short rill east of *Schneckenberg*, cutting through the mountain δ 1 in a direction from east to west	30	1·0
24.	Perhaps a rill from northern end of δ. (Distance of its northern end)	10	4·0
25.	A prolongation of the northern end of Hyginus rill, apparently bending round in a westerly direction towards the northern end of δ, and becoming narrower		
26.	Some dark spots north and south of Hyginus rill, seen occasionally, in addition to those generally visible		

(The above objects were observed by Miss Ashley.)

27.	A deep narrow rill west of *N*. Seen by Klein, *S. J.* i. 9		
28.	A more delicate rill nearer *N*. Klein. See also Neison, *S. J.* iv. 28		
29.	A rill from *p* to rill ii., touching *x* and *s* (continuation of rill ψ). *S. J.* i. 25, and iv. 14 (Gaudibert)		
30.	Eastern end of Ariadæus rill, passing *c* and ending at *x*. *S. J.* i. 25 (Schmidt)		

31. Eastern end of Ariadæus rill, ending at *p*. *S. J.* i. 25 (Lohrmann)
32. Cleft and crater in dark spot *m*. *S. J.* i. 26 (Gruithuisen)
33. Rill vii. (ψ) passing *north* of *z*. *S. J.* i. 26 (Lohrmann)
34. Rill vii. (ψ) passing *south* of *z*. *S. J.* i. 26 (Klein and Gaudibert)
35. Rill crossing *z*. Chart No. 1
36. A number of very small craterlets between the Schneckenberg and eastern end of Hyginus rill. *S. J.* ii. 20 (Edgcumbe)
37. Craterlet on north edge of *Schneckenberg* (Is it *g*?). *S. J.* ii. 28 (Gaudibert)
38. Two shallow valleys or low ridges, south of *Hyginus*. Compare Pratt's valley from *a* to *Hyginus*. *S. J.* iii. 42 (Neison)
39. A long valley-like depression, west of *T*. *S. J.* ii. 42 (Neison)
40. A large round dark spot or depression, west of *N*. *S. J.* ii. 42 (Neison)
41. A wide shallow valley, with a small craterlet or triple-peaked hill on its eastern slope, between *N* and the western arm of the *Schneckenberg*. *S. J.* v. 28 (Neison)
42. A low ridge, forming the western border of this valley (Neison)
43. A white hill on a ridge on south-east border of *N*. *S. J.* ii. 17 (Neison)
44. Two ridges on a mound between *N* and *Schneckenberg*. *S. J.* ii. 83 (Gaudibert)
45. Minute craterlet on the summit of a ridge west of *Schneckenberg*. *S. J.* ii. 82 (Gaudibert)
46. A rather large elliptical mound lying east and west, near the position of *N*. *S. J.* ii. 84 (Gaudibert). Possibly the same as 44
47. Minute craterlet or hillock on this mound. *S. J.* ii. 84 (Gaudibert). Possibly the same as 45
48. A long rounded ridge, running at N.W. direction between *N* and *Schneckenberg*. *S. J.* iii. 25 (Rand Capron). Perhaps the same as 46
49. Many delicate long hills in the place of *N*, and to the south-east. *S. J.* v. 4 (Schmidt)
50. Four or five small hills in position of *N*. *S. J.* v. 10 (Schmidt)
51. Several hills between *N* and *Schneckenberg*. *S. J.* v. 49 (McCance)
52. Small crater-like object half-way between *N* and the *Schneckenberg*. *S. J.* iv. 4 (Elger)
53. A rill on southern border of the ridge *σ*. *S. J.* v. 28 (Neison)
54. Three peaks on *κ*. *S. J.* iii. 35 (Backhouse)
55. Craterlet close to *x*. *S. J.* iv. 13. (Gaudibert)
56. Craterlet E.S.E. of *x*, twice as far from *x* as *x* is from the last. *S. J.* iv. 13 (Gaudibert)
57. One of these (55 or 56) also seen by Elger. *S. J.* iv. 4 and iv. 29

58. Two minute craterlets S.W. of *t*. *S. J.* iv. 84 (Stevenson). Possibly the same as last.
59. A very delicate double crater S.W. of *N*. *S. J.* v. 4 (Schmidt). Is this the same as 58?
60. A small crater east of *t*. *S. J.* iv. 84 (Stevenson)
61. A crater on northern end of ξ (Schmidt)
62. A small crater on the west side of *T*. See *Observatory*, vol. iii. p. 363 (Pratt)
63. Some rounded hills near the position of *N*. *Observatory*, vol. ii. p. 299 (Pratt). Compare with 49
64. A series of low curved banks, west of *T*. *Observatory*, vol. ii. p. 299 (Pratt)
65. Valley from *a* to *Hyginus*. *Observatory*, vol. ii. p. 299 (Pratt)

DUN ECHT CIRCULAR, No. 65.

Elements and ephemeris of the great comet of 1882, by Karl Zelbr.

(From *Astronomische Nachrichten* Nos. 2463 and 2466.)

Elements.

$$T = 1882,\ \text{September } 17{\cdot}2485 \text{ m. Z. Berlin.}$$

$$\left.\begin{aligned}\pi - \Omega &= 69^\circ\ 56'\ 58''{\cdot}1\\ \Omega &= 346\ \ 13\ \ 37{\cdot}8\\ i &= 142\ \ \ 3\ \ \ 7{\cdot}7\end{aligned}\right\}\ \text{m. Æq., } 1882{\cdot}0.$$

$$\log . q = 7{\cdot}906820$$

$$x = r\,[9{\cdot}995296]\ \sin\,(170^\circ\ 53'\ 22''{\cdot}2 + v)$$

$$y = r\,[9{\cdot}987766]\ \sin\,(262\ \ 55\ \ 52.6 + v)$$

$$z = r\,[9.441008]\ \sin\,(\ 49\ \ 52\ \ 28{\cdot}3 + v)$$

Ephemeris for Berlin midnight.

1882	α h. m. s.	δ ° ′	log σ	H	Culm. Z. h.
Nov. 7	9 44 34	—22 1·4		0·23	
11	9 36 55	23 22·4		0·21	
15	9 28 33	24 39·3		0·19	
19	9 19 2	25 51·4		0·17	
23	9 9 36	26 57.7		0·16	
27	8 59 2	27 56·9		0·14	
Dec. 1	8 47 45	28 48·1	0·182	0·13	16·1
16	8 1	30·5	0·200	0·10	14·3
31	7 15	29·5	0·236	0·07	12·6
1883					
Jan. 15	6 37	26·4	0·287	0·04	11·0
30	6 12	22·5	0·347	0·03	9.6
Feb. 14	5 57	18·5	0·409	0·02	8·4
Mar. 1	5 52	—15·1	0·469	0·01	7·2

We are indebted to Mr. J. Ritchie, Jr. for pointing out an error in Dun Echt Circular No. 55. Comet Barnard was discovered on September 13th and not on September 10th, as erroneously stated there, the corresponding word of the message having been mutilated in transmission.

In Circular 59 it should have been $\Omega = 342^\circ\ 39'$, instead of 29′.

Lord Crawford's Observatory, J. G. LOHSE.
Dun Echt: 1882, November 14.

DUN ECHT CIRCULAR, No. 66.

Orbit of the great Comet of 1882.

(From *Science Observer* Special Circular No. 29.)

Elements.

By Mr. S. C. Chandler, Jr.

$$\begin{array}{rl} T & = 1882,\ \text{September } 17{\cdot}2304,\ \text{Greenwich M.T.} \\ \pi & = 55^\circ\ 12'\ 41''{\cdot}2 \\ \pi\text{-}\Omega & = 69\ \ 22\ \ 7{\cdot}2 \\ \Omega & = 345\ \ 50\ \ 34{\cdot}0 \\ i & = 141\ \ 54\ \ 56{\cdot}2 \end{array} \left.\vphantom{\begin{array}{l}1\\1\\1\\1\end{array}}\right\} 1882{\cdot}0$$

$$\log. q = 7{\cdot}8835636$$

$$e = 0{\cdot}9999700$$

Constants for the Equator. (1882·0).

$$x = r\ [9{\cdot}9950007]\ \sin\ (170^\circ\ 35'\ 53''{\cdot}8 + v)$$
$$y = r\ [9{\cdot}9876224]\ \sin\ (262\ \ 42\ \ 59{\cdot}4 + v)$$
$$z = r\ [9{\cdot}4465116]\ \sin\ (\ 48\ \ 59\ \ 30{\cdot}2 + v)$$

Ephemeris for Greenwich Noon.

By J. Ritchie, Jr.

1882.	α h. m. s.	δ ° ′ ″	log Δ	log r	Light
Nov. 1	9 55 47·64	—19 43 44·9	0·169274	0·139490	1·00
3	9 52 33·00	20 26 54·1			
5	9 49 10·19	21 9 24·7	0·171050	0·164384	0·90
7	9 45 38.51	21 51 13.2			
9	9 41 57·40	22 32 15·6	0·172413	0·187309	0·79
11	9 38 6·33	23 12 26·8			
13	9 34 4·84	23 51 41·0	0·173558	0·208552	0·71
15	9 29 52·55	24 29 52·2			
17	9 25 29·21	25 6 53·1	0·174686	0·228343	0·65
19	9 20 54·62	25 42 36.2			
21	9 16 8·71	26 16 53.8	0·176000	0·246868	0·59
23	9 11 11·50	26 49 37·6			
25	9 6 3·12	27 20 38·9	0·177689	0·264278	0·54
27	9 0 43·79	27 49 48·9			
29	8 55 13·90	28 16 58·8	0·179941	0·280702	0·50
Dec. 1	8 49 33·96	28 41 59·6			
3	8 43 44·56	29 4 42·3	0·182926	0·296243	0·46
5	8 37 46·49	29 24 58·1			
7	8 31 40·65	29 42 39·0	0·186812	0·310991	0·42
9	8 25 28·25	29 57 38·1			
11	8 19 10·40	30 9 49·2	0·191740	0·325027	0·38
13	8 12 48·40	30 19 7·3			
15	8 6 23·73	30 25 29·2	0.197822	0·338411	0·35
17	7 59 57·98	30 28 53·0			
19	7 53 32·66	30 29 19·1	0·205138	0·351206	0·32
21	7 47 9·31	30 26 49·4			
23	7 40 49·38	30 21 26·8	0·213708	0·363458	0·29
27	7 28 25·62	30 2 23·4	0·223524	0·375213	0·26
31	7 16 31·79	—29 33 1·8	0·234535	0·386508	0·24

Lord Crawford's Observatory,
Dun Echt: 1882, November 22.

ASTRONOMICAL OCCURRENCES FOR DECEMBER, 1882.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
Fri	1		Sidereal Time at Mean Noon 16h. 40m. 57·75s.	1st Ec. D.	17 8 45	Saturn. 10 35·6
Sat	2	2 56	☾ Moon's Last Quarter	2nd Sh. E. 2nd Tr. E. 1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	6 45 7 33 14 27 14 51 16 43 17 6	10 31·4
Sun	3		Sun's Meridian Passage 9m. 59·33s. before Mean Noon	3rd Sh. E. 3rd Tr. E. 1st Ec. D. 1st Oc. R.	5 55 7 25 11 37 22 14 13	10 27·2
Mon	4			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	8 56 9 17 11 11 11 32	10 22·9
Tues	5	7	Conjunction of Mars and Venus 0° 6′ N.	1st Ec. D. 1st Oc. R. 2nd Sh. I. 2nd Tr. I.	6 5 55 8 39 17 19 17 56	10 18·7
Wed	6	 5	TRANSIT OF VENUS across Sun's disc Inferior conjunction of Venus and Sun	1st Tr. E. 3rd Ec. D.	5 58 17 12 7	10 14·5
Thur	7			2nd Ec. D. 2nd Oc. R.	12 29 18 15 42	10 10·3
Fri	8	23	Conjunction of Venus and Mercury 1° 12′ S.	1st Ec. D.	19 3 4	10 6·1
Sat	9	16 19	Conjunction of Moon and Venus 1° 14′ S. Conjunction of Moon and Mercury 2° 51′ S.	2nd Sh I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E. 1st Sh. I. 1st Tr. E. 1st Sh. E. 1st Tr. E.	6 37 7 3 9 21 9 47 16 22 16 34 18 37 18 50	10 1·9
Sun	10	3 37 3 13	● New Moon Conjunction of Moon and Mars 3° 1′ S. Conjunction of Mars and Sun Saturn's Ring: Major axis=45″·48 Minor axis=17″·43	3rd Sh. I. 3rd Tr. I. 3rd Sh. E. 3rd Tr. E. 1st Ec. D. 1st Oc. R.	7 18 8 6 9 56 10 42 13 31 44 15 56	9 57·7
Mon	11			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	10 50 11 0 13 6 13 15	9 53·5
Tues	12			1st Ec. D. 1st Oc. R.	8 0 10 22	9 49·3
Wed	13			1st Sh. I. 1st Tr. I. 1st Sh. E. 1st Tr. E.	5 19 5 26 7 34 7 41	9 45·1
Thur	14	7 53 18 19	Occultation of γ Aquarii (4½) Conjunction of Mars and Mercury 0° 38′ S. Uranus at quadrature with Sun	2nd Ec. D. 2nd Oc. R.	15 4 50 17 56	9 40·9
Fri	15		Illuminated portion of disc of Venus=0·028 Illuminated portion of disc of Mars=1·000			9 36·7

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
						Saturn.
Sat	16	17	Superior conjunction of Mercury and Sun Sidereal Time at Mean Noon 17h. 40m. 6·10s.	2nd Sh. I. 2nd Tr. I. 2nd Sh. E. 2nd Tr. E. 1st Sh. I. 1st Tr. I.	9 13 9 7 11 57 12 1 18 16 18 18	9 32·5
Sun	17	20 4 39 2 45 3 53 7 12 8 44 9 47	Jupiter at opposition to the Sun ☽ Moon's First Quarter Occultation of λ Piscium (5) Reappearance of ditto Near approach of B.A.C. (6½) Occultation of 22 Piscium (6) Reappearance of ditto	3rd Sh. I. 3rd Tr. I. 3rd Sh. E. 3rd Tr. E. 1st Oc. D. 1st Oc. R.	11 17 11 21 13 56 13 56 15 25 17 40	9 28·3
Mon	18		Sun's Meridian Passage 3m. 80·5s. before Mean Noon	2nd Oc. R. 1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	7 3 12 44 12 44 14 59 15 0	9 24·2
Tues	19	7 5	Near approach of π Piscium	1st Oc. D. 1st Oc. R.	9 50 12 6	9 20·1
Wed	20	6 0	Near approach of 39 Arietis (6½)	1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	7 9 7 13 9 25 9 29	9 15·9
Thur	21	7 33 2	Near approach of B.A.C. 1096 (5½) Conjunction of Mars and Saturn 2° 21′ S.	1st Ec. R. 1st Oc. D.	6 34 51 17 25	9 11·8
Fri	22	5 14	Near approach of ε Tauri (3½)	1st Sh. E.	3 57	9 7·6
Sat	23	18 28 18 56 15	Occultation of χ^2 Orionis (6) Reappearance of ditto Conjunction of Moon and Jupiter 2° 38′ S.	2nd Tr. I. 2nd Sh. I. 2nd Tr. E. 2nd Sh. E.	11 32 11 49 14 16 14 34	9 3·5
Sun	24	3 41	○ Full Moon	3rd Tr. I. 3rd Sh. I. 1st Oc. D. 3rd Tr. E. 3rd Sh. E.	14 35 15 16 17 8 17 11 17 57	8 59·4
Mon	25			2nd Oc. D. 2nd Ec. R. 1st Tr. I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	6 32 9 36 57 14 27 14 39 16 42 16 55	8 55·3
Tues	26	16 30	Near approach of B.A.C. 2872 (6)	1st Oc. D. 1st Ec. R.	11 34 14 0 58	8 51·2
Wed	27	7 49	Occultation reappearance of κ Cancri (5)	1st Tr I. 1st Sh. I. 1st Tr. E. 1st Sh. E.	8 53 9 8 11 8 11 23	8 47·1
Thur	28	13 29 14 47 18 39 18 53	Occultation of 14 Sextantis (6) Reappearance of ditto Occultation of 19 Sextantis (6) Reappearance of ditto	1st Oc. D. 3rd Ec. R. 1st Ec. R.	6 0 7 42 32 8 29 45	8 42·9
Fri	29	16 46	Near approach of 55 Leonis (6)	1st Tr. E. 1st Sh. E.	5 34 5 52	8 38·8
Sat	30		Saturn's Ring: Major axis=44″·38 Minor axis=16″·87	2nd Tr. I. 2nd Sh. I. 2nd Tr. E. 2nd Sh. E.	13 47 14 26 16 31 17 11	8 34·7
Sun	31			3rd Tr. I. 1st Oc. D.	17 51 18 52	8 30·6

THE PLANETS FOR DECEMBER.

At Transit over the Meridian of Greenwich.

Planets.	Date.	Rt. Ascension.	Declination.	Diameter.	Meridian Passage.
		h. m. s.	° ′		h. m.
Mercury ...	1st	16 0 3	S. 20 53½	4″·8	23 15·3
	9th	16 52 52	S. 23 19½	4″·6	23 36·5
	17th	17 40 52	S. 24 48	4″·6	23 59·9
	25th	18 37 16	S. 25 8	4″·8	0 21·6
Venus ...	1st	17 5 19	S. 24 21½	61″·8	0 24·3
	9th	16 43 32	S. 21 29	63″·4	23 27·2
	17th	16 28 31	S. 19 7	58″·4	22 40·8
	25th	16 22 59	S. 17 35	52″·4	22 3·8
Jupiter ...	1st	5 53 27	N. 23 2½	44″·2	13 10·3
	9th	5 49 0	N. 23 2½	44″·6	12 34·5
	17th	5 44 20	N. 23 2½	44″·6	11 58·3
	25th	5 39 39	N. 23 1½	44″·4	11 22·2
Saturn ...	1st	3 18 19	N. 15 48	18″·1	10 35·6
	9th	3 16 0	N. 15 40½	18″·0	10 1·9
	17th	3 13 58	N. 15 34½	18″·0	9 28·3
	25th	3 12 17	N. 15 29½	17″·8	8 55·3
Neptune ...	3rd	2 59 21	N. 15 6½	...	10 8·8
	19th	2 57 55	N. 15 1	...	9 4·5

Mercury rises about three-quarters of an hour before the sun, at the beginning of the month, the interval decreasing. Towards the end of the month he sets after the sun, the interval increasing to half an hour by the last day.

Venus is too close to the sun to be well observed at the beginning of the month, rising nearly at the same time as the sun on the 6th. On the 31st she rises nearly three hours before the sun.

Jupiter rises about an hour after sunset, at the beginning of the month, the interval decreasing.

Saturn sets about an hour and a half before sunrise, at the beginning of the month, the interval increasing.

TRANSIT OF VENUS.

A transit of Venus across the sun's disc, partly visible at Greenwich, will take place on Dec. 6, 1882.

	G.M.T.	h. m. s.
External contact at ingress, Dec. 6	...	1 55 57
Internal contact at ingress	...	2 16 18
Least distance of centres 10′ 41″·4...	...	5 4 2
Internal contact at egress	...	7 51 46
External contact at egress	...	8 12 9

Angle from north point { Contact at ingress 145° towards the E.
Contact at egress 114° towards the W.

For direct image.

Books received.—Greenwich Spectroscopic and Photographic Results. 1881.—Rudimentary Astronomy. By R. Main. Revised by W. T. Lynn. London: Crosby, Lockwood & Co. 1882.—Minutes of Proceedings of the Intercolonial Meteorological Conference, 1881. Adelaide: E. Spiller. 1881.—The Doomed Comet. By J. H. W. Oliver.—Observation du Spectrosolaire. Par M. Langley.—Annals of the Astronomical Observations of Harvard College. Vol. XIII., Part 1. Cambridge: Wilson & Son. 1882.—The Sun, its Planets and their Satellites. By Edmund Ledger. London: Edward Stanford. 1882.—Transit Tables for 1882. By Latimer Clark, M.I.C.E. London: Published by the Author, at 6, Westminster Chambers, S.W. 1882.—Ciel et Terre. Brussels: F. Hayez.—L'Astronomie. Paris: Gaultier-Villiers.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To Dec., 1882.

Dobie, Dr.
Langley, Prof.
Lawes, H. K.

To Feb., 1883.

Cruickshank, J.

To Dec., 1883.

Eadie, J. H.
Noble, Capt. W.
Taplin, W. G.

TO CORRESPONDENTS.

We reprint Mr. C. Leeson Prince's valuable letter, as the illustrations were accidentally misplaced.

All communications of any kind should be addressed to the Editor, 11, Angel Court, Throgmorton Street, London, E.C.

We cannot publish communications which are not authenticated by the name and address of the sender, as a guarantee of good faith.

When subscriptions sent by post are not acknowledged in the next number, the Editor will be much obliged if subscribers will *at once* inform him of the fact.

All Letters requiring an answer must enclose a penny stamp.

The Editor will be obliged if those gentlemen who have not paid their subscriptions will kindly send them by Cheque, Post-office Order, or *penny* postage stamps, but the Editor will not be liable for loss in transmission.

Post Office Orders for *the Editor* are to be made payable to JOHN C. JACKSON, Chief Office, London.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage to all parts of Great Britain and Ireland) is fixed at **Three Shillings** per Quarter, *payable in advance*, by Penny postage stamps or otherwise. Subscribers in America may remit, either by post office order or in notes, 3½ dollars, in payment of one year's subscription, postage included.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Rev. J. C. JACKSON, 11, *Angel Court, Throgmorton Street, E.C.,* **not later than the 20th of the Month.**

NOTICE.

It has been suggested to us that a General Index of our first Twenty Volumes would be both useful and agreeable to our Subscribers. Such an index could be supplied to Subscribers for 3s. 6d. per copy, in advance, provided a sufficient number of copies were ordered. If this suggestion meets with the necessary support of our Subscribers, we shall be glad to put the matter in hand. **An immediate application is requested.**

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

To all communications must be annexed the name and address of the sender, as a guarantee of good faith.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

SATURN'S RING.

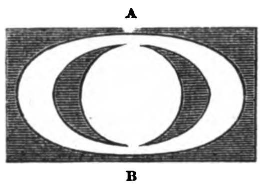
Sir,—You will probably have seen in *The Observatory* for the current month, as well as in *Knowledge*, Vol. II., No. 48, that an enquiry has been made respecting the amount of credit which is due to the Messrs. Ball for their supposed discovery of the primary division in the ring of Saturn. As it is possible that some of your readers may not have seen some of these papers, I thought the following statement might be of interest to them. It is a somewhat extraordinary circumstance that Mr. Wm. Ball and his brother, Dr. Ball, should have been credited during the last forty or fifty years with the honour of being the discoverers of this feature in Saturn's ring, and which has been styled by many eminent astronomers, up to the present year, as "Ball's division."

In the year 1880, it occurred to W. T. Lynn, Esq., F.R.A.S., to refer to the original communication of the Messrs. Ball to the Royal Society. In doing so he found no positive conclusion could be drawn about their assumed discovery without their drawing, which, for some unaccountable reason, was not given in three copies of Vol. I. of *Phil. Trans.* which he had examined. Mr. Lynn did not prosecute this enquiry any further until he paid me a visit on Sept. 15, 1882, when we discussed the subject, and I stated to him that for many years I had been impressed with the idea that Cassini—not Ball—had discovered the primary division in Saturn's ring, and I showed him Lowthorp's "Abridgment" of the early volumes of the *Phil. Trans.*, as my authority for the supposition. In this volume Mr. Lynn found Ball's drawing of the planet, which referred to the observation of Oct. 13th, 1665. The following is a verbatim copy of the original paper in the *Phil. Trans.*, which was as follows:

"This observation was made by Mr. William Ball, accompanied by his brother, Dr. Ball, Oct. 13, 1665, at Mainhead, near Exeter, in Devonshire, with a very good telescope near 38 feet long, and a double eyeglass, as the observer himself takes notice, adding that he never saw that Planet more distinct. The observation is represented by figure 3, concerning which the Author saith in his letter to a friend as follows: This appeared to me, the present

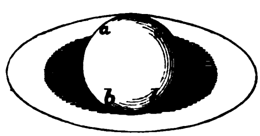
figure of Saturn, somewhat otherwise than I expected, thinking it would have been decreasing, but I found it full as ever, and a little hollow above and below. Whereupon the Person to whom notice was sent hereof, examining this shape, hath by letters desired the worthy Author of the System of this Planet, that he would now attentively consider the present figure of his anses or ring, to see whether the appearance be to him as in this figure, and consequently whether he there meets with nothing, that may make him think, that it is not *one* body of a *circular figure* that embraces his *disk* but *two*. And to the end that other curious men, in other places might be engaged to joyn their observations with him, to see whether they can find the like appearance to that represented here, especially such Notches and Hollownesses as at A. B. it was thought fit to insert here this newly related Account."

It is not stated who the "Person" was to whom this letter was sent, but in all probability it was either Wallis, Huyghens, or Hooke. The annexed copy of Ball's drawing I have copied from Lowthorp.



Now, in this plate, not the slightest trace of any division in the ring is to be seen, and I consider that a very great misapprehension has arisen as to the precise meaning of the following words: "Whether he there meets with nothing that may make him think that it is not *one* body of a circular figure that embraces his disc but *two*." I am disposed to think that he meant the two ansæ; for what reference could "Notches and Hollownesses" have to a *line* of division on the ring?

The next engraving, in order of date, is Hooke's, of which the following is a representation—

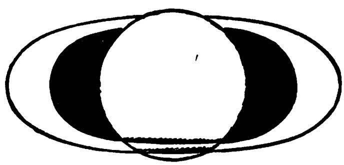


It refers to an observation by him on June 29, 1666, viz.:—"Between 11 and 12 at night I observed the body of Saturn through a 60 foot telescope, and found it *exactly* of the shape

represented in the figure. The ring appeared of a somewhat brighter light than the body; and the black lines *a a* crossing the ring, and *b b* crossing the body (whether shadows or not I dispute not) were plainly visible; whence I could manifestly see that the southernmost part of the ring was on this side of the body, and the northern part behind or covered by the body."

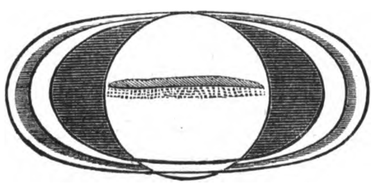
In Hooke's drawing no trace of a division in the ring is perceptible, which would surely have been the case had he supposed that Ball had really made such a very important discovery. The lines *a a b b* which he describes as crossing the ring are fully accounted for in the explanation of the plate, and can only be intended to show his ideas as to the shadow of the planet falling upon the ring, and that of the ring upon the planet.

The next engraving is by Hevelius, dated August, 1675.



It is interesting, as showing how much better he had been enabled to inform himself of the relatively true form of Saturn and its ring. Had Ball really discovered the division Hevelius was not a man who would have omitted, either to satisfy himself of the truth of such discovery or to have omitted its insertion into his own drawing upon its confirmation. I must, therefore, maintain that, up to the year 1675, the division in Saturn's ring had not been discovered.

The next and most important engraving relating to this enquiry is by Cassini, and bears date August, 1676.



We have here, for the first time, an actual drawing of the division in the ring, and his communication to the Royal Society runs thus—

"Ex Schemate Saturni à Hevelio ante annum observato video, cum Telescopis nostris longè inferioribus, uti. Tunc enim temporis (ut et nunc Aug., 1676,) cernebatur nobis in

Saturni Globo Zona subobscura, paulô Australior centro, instar Zonarum Jovialium. Deinde latitudo Annuli dividebatur bifariam, Lineâ obscurâ apparenter Ellipticâ revera Circulari quasi in duos annulos concentricos, quorum interior exteriori lucidior erat. Hanc phasim statim post emersionem Saturni ê Solaribus radiis per annum usque ad ejus immersionem conspexi; primo quidem, Telescopio Pedum 35, deindè minori, Pedum 20."

The above appears to me a plain and decided announcement of the discovery, and makes no allusion whatever to any previous observation of the kind.

A confirmation of Cassini's discovery may be found in Dr. Smith's Optics, 4to, 1738, Vol. II., p. 440, from which the following is an extract:—

"In the year 1676, after Saturn had emerged from the Sun's rays, Sig. Cassini saw him in the morning twilight with a darkish belt upon his globe, parallel to the long axis of his ring, as usual. But what was most remarkable the broadside of the ring was bisected quite round by a dark elliptical line, dividing it, as it were, into two rings, of which the inner ring appeared brighter than the outer one, with nearly the like difference in brightness, as between that of silver polished and unpolished; which, *though never observed before*,* was seen many times after, with tubes of 34 and 20 feet; and more evidently in the twilight, or moonlight, than in a darker sky."

I am informed that there are other astronomical works which attribute to Cassini the discovery of the division in Saturn's ring; but during the present century, Kitchener in 1825, Smyth in 1844, Hind in 1852, Proctor in his "Saturn," p. 49, Breen in "Planetary Worlds," p. 217, &c., all repeat the story of the brothers Ball having discovered this feature in the ring of Saturn. I have made this inquiry in the hope of elucidating the truth, and of recovering for Cassini the honour which would appear to be due to him.

I beg to remain, Sir, your obedient servant,

The Observatory, Crowborough: C. LEESON PRINCE.
Oct. 6, 1882.

P.S.—I may perhaps mention that a few days after my discussion with Mr. Lynn upon this subject, I had the pleasure of an interview with Capt. Noble, F.R.A.S., of Forest Lodge, Maresfield, to whom I explained the nature of this discussion and its result. It is satisfactory to find, by two letters which this well-known practical astronomer has written to a contemporary that, after taking time fully to consider the matter, he has arrived at the same conclusion with Mr. Lynn and myself.

* The italics are mine.

GENERAL INDEX

TO THE

FIRST TWENTY VOLUMES

OF

The Astronomical Register.

BY

F. W. LEVANDER, F.R.A.S.,

ONE OF THE ASSISTANT MASTERS IN UNIVERSITY COLLEGE SCHOOL, LONDON;

AUTHOR OF

"SOLUTIONS OF QUESTIONS IN MAGNETISM AND ELECTRICITY,"

AND EDITOR OF "MATRICULATION QUESTIONS IN HISTORY AND GEOGRAPHY."

London:

PRINTED FOR THE EDITOR BY ALABASTER, PASSMORE, & SONS,

FANN STREET, ALDERSGATE STREET, E.C.

1883.

PREFACE.

THE first Twenty Volumes of the ASTRONOMICAL REGISTER contain the records of all the discoveries that have been made and theories advanced in Astronomy during the last twenty years: they contain, in fact, the materials for a history of Astronomy during that period.

The discussions on papers read before the Royal Astronomical Society are there reported, and for several years these are not to be found elsewhere. The publications of the Royal Astronomical Society—only of late years accessible to the general public—contain no account of these discussions, in which so many useful hints are dropped, observations noted, and suggestions thrown out; while for many years the *Astronomical Register*, the first English periodical devoted solely to Astronomy, was without a competitor. To the accuracy with which these discussions are reported public testimony has been borne by distinguished astronomers at various times, both at home and abroad.

Although each volume has its Index, a considerable loss of time is necessarily involved in searching for any particular subject, especially if the exact volume containing the required information is not known. The present General Index has been compiled for the purpose of preventing this loss of time. As on examination some of the Indexes were found to be not quite so complete as they ought to have been, and also to contain some typographical errors, the whole of the 6,000 pages, comprised in Volumes I. to XX., have been carefully gone through, and it is believed that nothing has been omitted.

May, 1883.

Corrigendum.

Page 14, line 17 from bottom, *for* 266, 270 *read* 266—270.

INDEX.

NOTE.—*In Vol. VII., pages* 245—248 *were accidentally repeated, and should be pages* 249—252. *They are denoted in the Index by an asterisk after the number.*

APPENDICES.

ENGRAVINGS.

FINIS.

Alabaster, Passmore, and Sons, Printers, Fann Street, London, E.C.